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DELTA Test Report

TEST Reg. no. 19

Test for Marine Type Approval of BAWAT CMU 1.0 for Ballast Water Treatment System

Performed for BAWAT A/S

DANAK-19/14449
Project no.: T208005
Page 1 of 64
including 7 annexes

1 September 2014

DELTA
Venlighedsvej 4
2970 Hørsholm
Denmark

Tel. +45 72 19 40 00
Fax +45 72 19 40 01
www.delta.dk
VAT No. 12275110

Title	Test for Marine Type Approval of BAWAT CMU 1.0 for Ballast Water Treatment System
Test object	1 pc. BAWAT CMU 1.0 part no. AB01 Detailed information is given in Section 2. The test object was received 9 April 2014.
Report no.	DANAK-19/14449
Project no.	T208005
Test period	9 April – 21 August 2014
Client	BAWAT A/S Lejrvej 25 3500 Værløse Denmark
Contact person	Ole Lüthcke Christensen E-mail: olc@bawat.dk
Manufacturer	Eltronic A/S
Specifications	IMO Resolution MEPC.174(58):2008: "Guidelines for approval of ballast water management systems (G8)" – "Part 3 – Specification for environmental testing for approval of ballast water management systems" IACS E10: Rev. 5, Dec 2006. "Test Specification for Type Approval". DNV Standard for Certification 2.4:2006: "Environmental test specification for instrumentation and automation equipment". USCG 46 CFR 162.060-30: "Testing requirements for ballast water management system (BWMS) components".
Results	No malfunctions were detected. The criteria for compliance are listed in Section 3.2.
Test personnel	Claus Momme Thomsen Henrik Klarskov Møller Olling Truelsen Carsten Kiørboe Jens Schoustrup-Thomsen Henrik Funding Raun Poul Nørgaard Torben Sibbern Larsen

Date 1 September 2014

Project manager

Henrik Funding Raun, B.Sc.E.E.
DELTA

Responsible

Susanne Otto, B.Sc.E.E., B.Com (Org.)
DELTA

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1. Summary of test

1.1 Test requirements

The following tests were carried out as agreed with the client.

Test	Test method
Visual inspection and performance test	IACS E10:2006
External power supply failure	IACS E10:2006
Power supply variations (permanent)	IACS E10:2006
Power supply variations (transient)	IACS E10:2006
Low temperature (cold)	IEC 60068-2-1:2007
Dry heat	IEC 60068-2-2:2007
Damp heat, cyclic	IEC 60068-2-30:2005
Insulation resistance (UN>65V)	IACS E10:2006
High voltage	IACS E10:2006
Vibration - Resonance search	IEC 60068-2-6:2007
Vibration - Endurance sinusoidal	IEC 60068-2-6:2007
Electrostatic discharge	IEC 61000-4-2:2008
Electromagnetic field	IEC 61000-4-3:2010
Conducted low frequency	IEC 61000-4-16:1998
Conducted Radio Frequency	IEC 61000-4-6:2013
Burst/Fast Transients	IEC 61000-4-4:2012
Surge/voltage	IEC 61000-4-5:2005
Radiated Emission	CISPR 16-2-3:2010
Conducted Emission	CISPR 16-2-1:2013
Enclosure protection, IP 5X	IEC 60529:2013
Enclosure protection, IPX4	IEC 60529:2013

1.2 Conclusion

The test object mentioned in this report meets the relevant requirements of the standards stated below.

- IMO Resolution MEPC.174(58):2008
- IACS E10: Rev. 5:2006
- DNV Standard for Certification 2.4:2006
- USCG 46 CFR 162.060-30

The test results relate only to the object tested.

2. Test objects

2.1 Test object

Test object 2.1.1

Name of test object	CMU
Model / type	BAWAT CMU 1.0
Part no.	AB01
Serial no.	124-00526-01
Manufacturer	Eltronic A/S
Supply voltage	230 VAC 50 Hz
Comments	CMU # 2 The cabinet was changed and mechanical stiffness increased during vibration testing.

The test object was modified in the course of the testing, please refer to Annex 6.

2.2 Auxiliary equipment

Auxiliary equipment 2.2.1

Name of auxiliary equipment	Fluke 177
Model / type	177
Part no.	N/A
Serial no.	21640347
Manufacturer	Fluke
Supply voltage	Battery
Comments	N/A

Auxiliary equipment 2.2.2

Name of auxiliary equipment	Laptop
Model / type	N/A
Part no.	N/A
Serial no.	N/A
Manufacturer	N/A
Supply voltage	N/A
Comments	Used for communication with embedded computer with remote desktop.

3. General test conditions

3.1 Test setup

A drawing of the test setup is enclosed in Annex 7.

3.2 Criteria for compliance

No change of the actual operational states of the test object is allowed. However, temporary change is allowed during the power supply failure test.

In addition, the following generic acceptance criteria for compliance were in force during the EMC immunity testing:

- Performance Criterion A: (For continuous phenomena): The test object shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed as defined in the relevant equipment standard and in the technical specification published by the manufacturer.
- Performance Criterion B: (For transient phenomena): The test object shall continue to operate as intended after the tests. No degradation of performance or loss of function is allowed as defined in the technical specification published by the manufacturer. During the test, degradation or loss of function or performance which is self-recoverable is, however, allowed but no change of actual operating state or stored data is allowed.
- Performance Criterion C: Temporary degradation or loss of function or performance is allowed during and after the test, provided the function is self-recoverable, or can be restored by the operation of the controls as defined in the relevant equipment standard and in the technical specification published by the manufacturer.

3.3 Functional test

A functional test was performed before, during (if specified) and after each test. The functional test was carried out in accordance with the functional test procedure provided by the client.

The functional test procedure is given in Annex 7.

3.4 Standard environment

Normal environmental condition:

Temperature	:	15 °C - 35 °C
Humidity	:	25 %RH - 75 %RH
Air pressure	:	86 kPa - 106 kPa (860 mbar - 1060 mbar)
Power supply voltage	:	U_{nom}. ±3 %

4. Test and results

4.1 Test summary

The following tests were carried out as agreed with the client.

Test name	CMU	CMU # 2 new cabinet
Visual inspection and performance test	OK 9-4-2014	
External power supply failure		OK 18-8-2014
Power supply variations (permanent)	OK 1-5-2014	
Power supply variations (transient)	OK 1-5-2014	
Cold	OK 11-4-2014	
Dry heat	OK 10-4-2014	
Damp heat, cyclic		OK 21-8-2014
Insulation resistance (UN>65V)	OK	OK
High voltage		OK 18-8-2014
Vibration - Resonance search		OK
Vibration - Endurance sinusoidal		OK 12-8-2014 to 15-8-2014
Electrostatic discharge	OK 1-5-2014	
Electromagnetic field	OK 28-4-2014	
Conducted low frequency	OK 30-4-2014	
Conducted Radio Frequency	OK 1-5-2014	
Burst/Fast Transients	OK 30-4-2014	
Surge/voltage	OK 1-5-2014	
Radiated Emission	OK 25-4-2014	
Conducted Emission	OK 25-04-2014	
Enclosure protection, IP5X	OK 9-5-2014	
Enclosure protection, IPX4	OK 8-5-2014	

4.2 Visual inspection and performance test

Specification & Test method

IACS E10, Test No. 1 and 2.

Procedure

The conformance to drawings and the functional performance are demonstrated to the classification society surveyors present at DELTA during the type approval testing.

The functional test is also demonstrated.

Results

The conformance to drawings and the functional performance, including the functional test procedure, were demonstrated. However, representatives from the classification societies were not present.

4.3 External power supply failure

Specification & Test method

IACS E10, Test No. 3.

DNV Standard for certification No. 2.4, clause 3.4.

Procedure

The power supply is interrupted 3 times within 5 minutes with a break time of 60 seconds.

Normal power-up procedure is to be obtained after each power break.

One of the power supply failures is made during the boot sequence.

Results

No malfunction was observed during the exposure, and the function of the test object was OK after each exposure.

Performance criterion: C.

Note 1: The start-up time of the BAWAT CMU 1.0 was 2 min 50 s. Thus, the total time for the 3 interruptions was approx. 10 minutes rather than the specified 5 min.

4.4 Power supply variations (permanent)

Specification & Test method

IMO Resolution MEPC.174(58), Part 3.

IACS E10, Test No. 4.

DNV Standard for certification No. 2.4, clause 3.5.

USCG 46 CFR 162.060-30.

Procedure

$U_{nom.}$	=	Nominal supply voltage	=	230 VAC
$f_{nom.}$	=	Nominal supply frequency	=	50 - 60 Hz

Exposures, each with a duration of 15 minutes, are performed at the following supply voltages and frequencies:

U	=	$U_{nom.}$ + 10 %	=	253 VAC
U	=	$U_{nom.}$ - 10 %	=	207 VAC
f	=	$f_{nom.}$ + 5 %	=	63 Hz
f	=	$f_{nom.}$ - 5 %	=	47.5 Hz

Results

No malfunction was observed during the exposure, and the function of the test object was OK after the exposure.

Performance criterion: A.

4.5 Power supply variations (transient)

Specification & Test method

IMO Resolution MEPC.174(58), Part 3.

IACS E10, Test No. 4.

DNV Standard for certification No. 2.4 clause 3.5.

USCG 46 CFR 162.060-30.

Procedure

$U_{nom.}$	=	Nominal supply voltage	=	230 VAC
$f_{nom.}$	=	Nominal supply frequency	=	50 – 60 Hz

Ten exposures, 1 / min, are carried out at each of the following combinations:

•	$U_{nom.}$ + 20 %	=	276 VAC	Duration	=	3.0 s
	$f_{nom.}$ + 10 %	=	66 Hz	Duration	=	5.0 s
•	$U_{nom.}$ - 20 %	=	184 VAC	Duration	=	3.0 s
	$f_{nom.}$ - 10 %	=	45 Hz	Duration	=	5.0 s

The test object is observed during the exposures, and a functional test is performed at the end of each combination.

Results

No malfunction was observed during the exposure, and the function of the test object was OK after the exposure.

Performance criterion: A

4.6 Low temperature (cold)

Specifications

IMO Resolution MEPC.174(58), Part 3.

IACS E10, Test No. 11.

DNV Standard for certification No. 2.4 clause 3.9.

USCG 46 CFR 162.060-30.

Test method

IEC 60068-2-1:2007, Test Ad: Cold test for heat-dissipating specimens with gradual change of temperature that are powered after initial temperature stabilization.

Severity and procedure

Temperature	:	0 °C
Duration	:	16 hours

The test object is de-energised during the exposure. However, during the last 2 hours of the exposure, the test object is energised and a functional test is performed.

After recovery, a functional test and an insulation resistance test ref. Section 4.9 is performed in standard environment.

Results

No malfunction was observed during the exposure. Further, the function of the test object was OK during the last 2 hours of the exposure and after recovery. The insulation resistance was OK after the exposure, ref. Section 4.9.

4.7 Dry heat

Specifications

IMO Resolution MEPC.174(58), Part 3.

IACS E10, Test No. 5.

DNV Standard for certification No. 2.4 clause 3.7.

USCG 46 CFR 162.060-30.

Test method

IEC 60068-2-2:2007, Test Be: Dry heat tests for heat-dissipating specimens with gradual change of temperature that are required to be powered throughout the test

Severity and procedure

Temperature	:	+55 °C / +70 °C
Duration	:	16 hours / 2 hours
Humidity	:	Below 50 %RH

The test object is energised and in normal operating condition during the exposure. During the last hour of the exposure, a functional test is performed.

After recovery, the functional test is repeated in standard environment.

Results

No malfunction was observed during the exposure. Further, the function of the test object was OK during the last hour of the exposure and after recovery.

It was observed that an internal temperature measurement on the mainboard and RAM generated an alarm during the +70 °C exposure. The function of the test object was OK and it was possible to acknowledge the alarm after the temperature was decreased below the alarm limit.

4.8 Damp heat, cyclic

Specifications

IMO Resolution MEPC.174(58), Part 3.

IACS E10, Test No. 6.

DNV Standard for certification No. 2.4 clause 3.8.

Test method

IEC 60068-2-30:2005, Test Db: Damp heat cyclic (12 + 12 hours' cycle), Variant 1.

Severity and procedure

Lower temperature	:	25 °C
Humidity range at lower temperature	:	95 - 100 %RH
Upper temperature	:	55 °C
Humidity range at upper temperature	:	90 - 96 %RH
Number of cycles	:	2

During the first cycle, the test object is energised and in normal operational mode. A functional test is performed during the first 2 hours of the 55 °C phase.

During the second cycle, the test object is de-energised. However, during the last 2 hours of the second 55 °C phase, the test object is energised and a functional test is performed.

After recovery the test object is energised and a functional test and an insulation resistance test ref. Section 4.9 is performed in standard environment.

Results

No malfunction was observed during the exposure, and the function of the test object was OK during the first and second cycle at 55 °C and 90 - 96 %RH and after recovery. The insulation resistance was OK after the exposure, ref. Section 4.9.

No corrosion attack was observed after the exposure.

4.9 Insulation resistance (UN>65V)

Specification & Test method

IACS E10, Test No. 9.

DNV Standard for certification No. 2.4 clause 3.12

Procedure

The insulation resistance is measured between shorted supply terminals and earth with 500 VDC. The insulation resistance is to be above 100 MΩ initially, and above 10 MΩ after the cold, damp heat, and high voltage exposures.

Results

Cable designation	Test condition	Test voltage [Vrms]	Duration [sec]	Insulation resistance
Power port	Initial	500 VDC	60 sec.	1.4 GΩ
	After Low temperature test	500 VDC	60 sec.	2.4 GΩ
	After Damp heat test	500 VDC	60 sec.	720 MΩ
	After High voltage test	500 VDC	60 sec.	6.6 GΩ

4.10 High voltage

Test method

IACS E10, Test No. 10.

DNV Standard for certification No. 2.4 clause 3.13.

Procedure

1500 VAC, 50 Hz is applied between shorted supply terminals and earth for 1 minute for the 230 VAC supply line.

No flashover, breakdown etc. is acceptable.

Results

No flashover or breakdown was observed during the exposure. The insulation resistance was OK after the exposure, ref. Section 4.9.

4.11 Vibration - Resonance search

Specifications

IMO Resolution MEPC.174(58), Part 3.

IACS E10, Test No. 7.

DNV Standard for certification No. 2.4 clause 3.6.

USCG 46 CFR 162.060-30.

Test method

IEC 60068-2-6:2007, Test Fc: Vibration (sinusoidal).

Severity and procedure

Frequency range	:	2 - 100 Hz		
Frequency / amplitude	:	2 - 13.2 Hz	:	±1 mm
		13.2 - 100 Hz	:	±0.7 g
Sweep rate	:	Max. 1 octave/min.		
Number of axes	:	3 mutually perpendicular		

The test object is de-energised during the exposure.

During the resonance search, the resonance frequencies are determined by means of stroboscopic light with slow motion facility and accelerometer measurements of the amplification factors (Q).

Resonance frequencies with an amplification factor above 2 are recorded. Resonances with amplification factors exceeding 10 are not accepted.

The resonance search is repeated after the endurance vibration exposure.

Results

The table below shows the result of the resonance search.

Place of measurement	**Axis**	**Measured frequency Before endurance [Hz]**	**Amplification factor Before endurance [Q]**	**Measured frequency After endurance [Hz]**	**Amplification factor After endurance [Q]**
Corner of power supply	X	38 98	2.2 6.2	41.8 93.3	4.4 2
	Y	100	2.2	91.2	2.1
	Z	83.9	4.6	83.9	2.3
Embedded computer	X	47.2 99.9	4.9 4.2	42.1 90.3 56.6	8.3 3 3.2
	Y	2 - 100	< 2	98.5	2.2
	Z	83.2	2.4	2 - 100	< 2

Place of measurement	Axis	Measured frequency Before endurance [Hz]	Amplification factor Before endurance [Q]	Measured frequency After endurance [Hz]	Amplification factor After endurance [Q]
LAN switch	X	34.5 46.5	2.1 2.6	41.8 89.8	5 2.6
	Y	87.9	2.7	87.9 98.5	2.4 2.7
	Z	83.2	2.4	2 - 100	< 2
I/O module	X	47.6 96.2	6.6 5.2	42.1 57.2 76.5 88.5	7.9 4.9 4.4 3.6
	Y	100	2.5	97	3.1
	Z	49.8	5.5	50.2	5.4
Main switch (in on position)	X	2 - 100	< 2	2 - 100	< 2
	Y	81.9	3.2	88.5	3.9
	Z	30.3	2.1	32	2.1

Measurement curves of the maximum amplification factors and resonance frequencies and definition of axes are enclosed in Annex 3.

4.12 Vibration - Endurance sinusoidal

Specification

IMO Resolution MEPC.174(58), Part 3.

IACS E10, Test No. 7.

DNV Standard for certification No. 2.4 clause 3.6.

USCG 46 CFR 162.060-30.

Test method

IEC 60068-2-6:2007, Test Fc: Vibration (sinusoidal).

Severity and procedure

Frequency range : 2 - 100 Hz

Frequency / amplitude : 2 - 13.2 Hz : ±1 mm
13.2 - 100 Hz : ±0.7 g

Procedure : Dwell on found resonances.

Dwell conditions : $Q < 2$: 4 hours at 30 Hz
$Q \geq 2$: 4 hours at each resonance frequency

Number of axes : 3 mutually perpendicular

A narrow sweep will be used if 2 resonances in the same axis are close to each other and the duration is increased to 320 min

The test object is energised and a functional test is performed during the entire exposure.

Results

Based on the results from the resonance search, the following endurance conditions were performed:

Axis	Frequency	Duration
X	Sweep 34 - 38 Hz Sweep 46 - 48 Hz Sweep 96 - 100 Hz	320 minutes 320 minutes 320 minutes
Y	Sweep 87 - 100 Hz Dwell 82 Hz	320 minutes 240 minutes
Z	Dwell 20 Hz Dwell 50 Hz Dwell 83 Hz	240 minutes 240 minutes 240 minutes

No malfunction was observed during the exposure and the function of the test object was OK during and after each endurance exposure.

Exposure curves and definition of axes are enclosed in Annex 3.

No damage was observed at the visual inspection performed after the exposures.

4.13 Electrostatic discharge

Specifications

IACS E10, Test No. 13.

DNV Standard for certification No. 2.4 clause 3.14.

Test method

IEC 61000-4-2:2008: Testing and measurement techniques - Electrostatic discharge immunity test.

Severity and procedure

Air discharge	:	2, 4 and 8 kV
Contact discharge	:	2, 4 and 6 kV
Energy storage capacitance	:	150 pF
Discharge resistance	:	330 Ω
Polarity	:	+ and -
Number of discharges	:	10 per polarity at each test point

The discharges are applied only to such points and surfaces of the test object, which are accessible to personnel during normal use.

Contact discharges are applied to conductive surfaces and both Horizontal and Vertical coupling planes. Air discharges are applied to insulating surfaces.

The test object is energised and in normal operational mode during the exposure. The test object is observed during the exposure, and a functional test is performed after the exposure.

Results

No malfunction was observed during the exposure and the function of the test object was OK after the exposure.

Performance criterion: B.

4.14 Electromagnetic field

Specifications

IACS E10, Test No. 14.

DNV Standard for certification No. 2.4 clause 3.14.

Test method

IEC 61000-4-3:2010: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.

Severity and procedure

Frequency range	:	80 - 2000 MHz
Field strength	:	10 V/m
Modulation	:	80 %AM, 1000 Hz sine wave

The test is performed in an anechoic room. The field is generated using linearly polarised broadband antennas.

The test object is energised and in normal operational mode during the exposure. The test object is observed during the exposure and a functional test is performed after the exposure.

Results

No malfunction was observed during the exposure and the function of the test object was OK after the exposure.

Performance criterion: A.

4.15 Conducted low frequency

Specification / Test method

IACS E10:2006, Test No. 15.

DNV Standard for certification No. 2.4 clause 3.14.

Severity and procedure

Frequency range	:	0.05 - 12 kHz
Amplitude (AC-supplied)	:	50 Hz - 15th harmonic : 10 % of $U_{nom.}$ 15th - 100th harmonic : 10 % - 1 % of $U_{nom.}$ 100th - 200th harmonic : 1 % of $U_{nom.}$
Maximum applied power	:	2.0 W

The impedance of the test generator is less than 1 Ω.

The test signal is superimposed on the power supply lines via a coupling transformer.

The test object is energised and in normal operational mode during the exposure. The test object is observed during the exposure, and a functional test is performed after the exposure.

Results

No malfunction was observed during the exposure, and the function of the test object was OK after the exposure.

Performance criterion: A.

4.16 Conducted Radio Frequency

Specification

IACS E10, Test No. 16.

DNV Standard for certification No. 2.4 clause 3.14.

Test method

IEC 61000-4-6:2013: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.

Severity and procedure

Frequency range	:	150 kHz - 80 MHz
Amplitude	:	10 V r.m.s. amplitude swept over the frequency range 150 kHz to 80 MHz (severity level 2); including 10 V r.m.s amplitude at spot frequencies: 2 MHz ; 3 MHz ; 4 MHz ; 6.2 MHz ; 8.2 MHz ; 12.6 MHz ; 16.5 MHz ; 18.8 MHz ; 22 MHz and 25 MHz.
Dwell time	:	3 seconds during sweeping and at spot frequencies
Sweep rate	:	$\leq 1.5 \times 10^{-3}$ decades/s
Modulation	:	80 %AM, 1000 Hz sine wave

The test object is supplied with power via a coupling / decoupling network.

The test signal is coupled to the power lines and signal lines via coupling networks or via an EM clamp. The coupling impedance is 150 Ω.

The test object is energised and in normal operational mode during the exposure. The test object is observed during the exposure, and a functional test is performed after the exposure.

Results

No malfunction was observed during the exposure, and the function of the test object was OK after the exposure.

Performance criterion: A.

4.17 Burst/Fast Transients

Specifications

IACS E10, Test No. 17.

DNV Standard for certification No. 2.4 clause 3.14.

Test method

IEC 61000-4-4:2012: Testing and measurement techniques - Section 4: Electrical fast transient / burst immunity test.

Severity and procedure

Amplitude	:	2 kV on power lines
	:	1 kV on signal lines
Pulse rise time	:	5 ns
Pulse duration	:	50 ns
Generator impedance	:	50 Ω
Repetition rate	:	5 kHz
Burst duration	:	15 ms
Burst period time	:	300 ms

Power port

The test object is supplied with power via a transient coupling network. The test signal is successively coupled to each power line and protective earth with reference to the ground plane.

The test signal is injected on the power lines for 5 minutes, using each coupling mode and each polarity, and then on the signal lines for 5 minutes using each polarity.

Signal lines

The test signal is injected on the signal lines using a capacitive coupling clamp. The clamp is successively used on selected signal cables.

The test object is energised and in normal operational mode during the exposure. The test object is observed during the exposure and a functional test is performed after the exposure.

Results

No malfunction was observed during the exposure and the function of the test object was OK after the exposure.

Performance criterion: B.

4.18 Surge/voltage

Specifications

IACS E10, Test No. 18.

DNV Standard for certification No. 2.4 clause 3.14

Test method

IEC 61000-4-5:2005: Testing and measurement techniques - Surge immunity test.

Severity and procedure

Amplitude power ports	:	1 kV line-to-earth, 0.5 kV line-to-line
Voltage rise time	:	1.2 µs (open circuit)
Voltage decay time	:	50 µs (open circuit)

The impedance of the test generator is 2 Ω for line-to-line coupling and 12 Ω for line-to-earth coupling.

The test object is energised and in normal operational mode during the exposure. The test object is observed during the exposure, and a functional test is performed after the exposure.

Results

No malfunction was observed during the exposure and the function of the test object was OK after the exposure.

Performance criterion: B.

4.19 Radiated Emission

Specification

IACS E10:2006, Section 19
DNV Standard for certification No. 2.4 clause 3.14

Test methods

CISPR 16-2-3:2010: Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-3: Methods of measurement of disturbance and immuni - Radiated disturbance measurements.

Severity and procedure

Frequency range	:	0.15 - 2000 MHz		
Limits (quasi-peak)	:	0.15 - 30 MHz	:	80 - 50 dBµV/m
		30 - 100 MHz	:	60 - 54 dBµV/m
		100 - 2000 MHz	:	54 dBµV/m, except for
		156 - 165 MHz	:	24 dBµV/m

The electromagnetic field is measured with antennas at a distance of 3 m.

The measuring bandwidth is, 9 kHz in the frequency range 150 kHz - 30 MHz and 120 kHz in the frequency range 30 MHz - 2000 MHz, except for the frequency range 156 MHz - 165 MHz where the measuring bandwidth is 9 kHz.

The test object is energised and in normal operational mode during the measurement.

Results

The radiated emissions were within the specified limits. Test record sheets of the radiated emission measurements are enclosed in Annex 4.

4.20 Conducted Emission

Specification

IACS E10:2006, Test. No. 20
DNV Standard for certification No. 2.4 clause 3.14

Test methods

CISPR16-2-1:2013: Specification for radio disturbance and immunity measuring apparatus and methods - Part 2-1: Methods of measurement of disturbances and immunity - Conducted disturbance measurements

Severity and procedure

Frequency range	:	0.01 - 30 MHz		
Limits (quasi-peak)	:	0.01 - 0.15 MHz	:	120 - 69 dBµV
		0.15 - 0.50 MHz	:	79 dBµV
		0.50 - 30 MHz	:	73 dBµV

The radio frequency voltage is measured at the power supply terminals of the test object by a receiver through an artificial mains network.

The measuring bandwidth is 200 Hz in the frequency range 10 kHz - 150 kHz and 9 kHz in the frequency range 150 kHz - 30 MHz.

The test object is energised and in normal operational mode during the measurement.

Results

The conducted emissions were within the specified limits. Test record sheets of the conducted emission measurements are enclosed in Annex 5.

4.21 Enclosure protection, IP5X

Specification & Test method

EN/IEC60529:2013 Degrees of protection provided by enclosures (IP Code).

Severity

IP 5X (dust protected):

Category	:	2 (no air pressure reduction)
Test means	:	Temperature stabilised surroundings
Test powder	:	Talcum
Air pressure	:	Normal air pressure
Duration	:	8 hours.

The test object is switched OFF during the exposure.

The test object is placed inside the dust test chamber in normal operating position. Hereafter, it is exposed to swirling dust conditions as described in the reference specification.

After the exposure, the test object is brushed down on all external surfaces. It is then carefully opened and visually inspected for ingress of dust. Special attention is paid to dust accumulated on parts critical to the functionality of the test objects.

The acceptance criterion for the IP 5X test is: “The protection is satisfactory if, on inspection, talcum powder has not accumulated in a quantity or location such that, as with any other kind of dust, it could interfere with the correct operation of the equipment or impair safety”.

Results

No dust was observed inside the test object during the visual inspection performed after the exposure. Further, the function of the test object was OK after the exposure.

4.22 Enclosure protection, IPX4

Specification

DNV Standard for certification No. 2.4

Test methods

Reference specification

EN/IEC 60529: Degrees of protection provided by enclosures (IP Code).

Severity

IP X4 (Protection against splashing water from all directions)

Procedure	:	Spray nozzle
Directions	:	±180° from vertical
Flow	:	10 l/min ±5%

Test duration	:	1 min per m^2 at least 5 minutes
Distance from nozzle to object	:	0.3 to 0.5 m.

The test object is switched ON during the exposure.

A function test is performed immediately after the test object is removed from the water test equipment. A visual inspection is performed after the function test.

Results

No accumulated water was observed inside the test object during the visual inspection performed after the exposure. Further, the function of the test object was OK after exposure.

Annex 1

List of instruments

List of instruments

NO.	DESCRIPTION	MANUFACTURER	TYPE NO.
29342	REFLECTOMETER COUPLER, 600-4200 MHz	ROHDE & SCHWARZ	ZPD
29691	0.01 - 20 GHz. SYNTH. SWEEPER	HEWLETT-PACKARD	83620A
29694	1-12 GHz. HORN ANTENNA.	LOGIMETRICS	AN 8200 F
29703	LF POWER AMPLIFIER	BRÜEL & KJÆR	2708
29744	RF DIRECTIONAL COUPLER, 26-1000 MHz, ROOM 1	SPINNER	BN 52 76 76
29806	BROADBAND POWER AMPLIFIER, 10 kHz-220 MHz, 75 W	AMPLIFIER RESEARCH	75A220
29827	ELECTRONIC SURGE GENERATOR	EM TEST	VCS 500
29832	DIFFERENTIAL HIGH VOLTAGE PROBE, DC-25 MHz	TEKTRONIX	P5200
29846	RF GENERATOR, 9 kHz-2.4 GHz	MARCONI	2024
29856	DIGITAL MULTIMETER W. HPIB	HEWLETT-PACKARD	34401A
29864	CAPACITIVE COUPLING CLAMP	DELTA EMC	IEC 1000-4-4
29898	3-LINE CDN NETWORK, IEC 61000-4-6	MEB	M3
29906	15 MHz FUNCTION / ARBITRARY WAVE GENERATOR	HEWLETT-PACKARD	33120A
29913	ELECTRICAL FAST TRANSIENT (BURST) GENERATOR	EM TEST	EFT 500
29969	EM INJECTION CLAMP, IEC 1000-4-6	MEB	KEMZ 801
29984	RF POWER AMPLIFIER, 0.8-2.2 GHz, 200W	MILMEGA	AS0822-200
29985	BILOG ANTENNA 26-2000 MHz	SCHAFFNER/CHASE	6140A
49173	HF GENERATOR	Marconi	2024
49517	GATE LEAKAGE TEST SET-UP AEC-Q100-006	DELTA	VBN
49534	SPITZENBERGER	SPITZENBERGER	PHD 13500/B
49535	SPITZENBERGER	SPITZENBERGER	PHD 13500/B
49536	SINGLE COIL LOOP	DELTA	
49562	ESD GENERATOR, AIR AND CONTACT DISCHARGE	SHAFFNER	NSG438
49617	HIGH POWER RF AMPLIFIER, 80-1000 MHz, 500 W	TESEQ	CBA1G-500
49669	OSCILLOSCOP	AGILENT	MSO7034A
EVFGT-15	EL.DYN SHAKER	LING DYNAMICS	V875-440
EVFGT-50	EL.DYN SHAKER	LING DYNAMICS	V875-440 LS
91a / 30669	ACCELEROMETER	BRÜEL & KJÆR	4371
96 / 1019464	ACCELEROMETER	BRÜEL & KJÆR	4371
71a / 2035921	ACCELEROMETER	BRÜEL & KJÆR	4393
72a / 31987	ACCELEROMETER	BRÜEL & KJÆR	4393
73 / 1823239	ACCELEROMETER	BRÜEL & KJÆR	4393
74a / 2185863	ACCELEROMETER	BRÜEL & KJÆR	4393
75ab / 31620	ACCELEROMETER	BRÜEL & KJÆR	4393
76 / 2080007	ACCELEROMETER	BRÜEL & KJÆR	4393
77 / 31991	ACCELEROMETER	BRÜEL & KJÆR	4393
78 / 31992	ACCELEROMETER	BRÜEL & KJÆR	4393
22575	ACC. PRE-AMP.	BRÜEL & KJÆR	2626
22585	ACC. PRE-AMP.	BRÜEL & KJÆR	2626
43235	VIBR. CONTROLLER	LDS DACTRON	LAS 200
43236	VIBR. CONTROLLER	LDS DACTRON	LAS 200
EVFGT-34	WET-ROOM	DELTA	IP Water
EVFGT-47	CLIMATIC CHAMBER	DELTA	VKF875-3
EVFGT-49	IP DUST	WEISS TECHNIK	ST 2000
43219	Megger	Megger	MIT430

Annex 2

Photos

Photo 1 Power supply variations.

Photo 2 Climatic testing.

Photo 3 Insulation resistance.

Photo 4 High voltage.

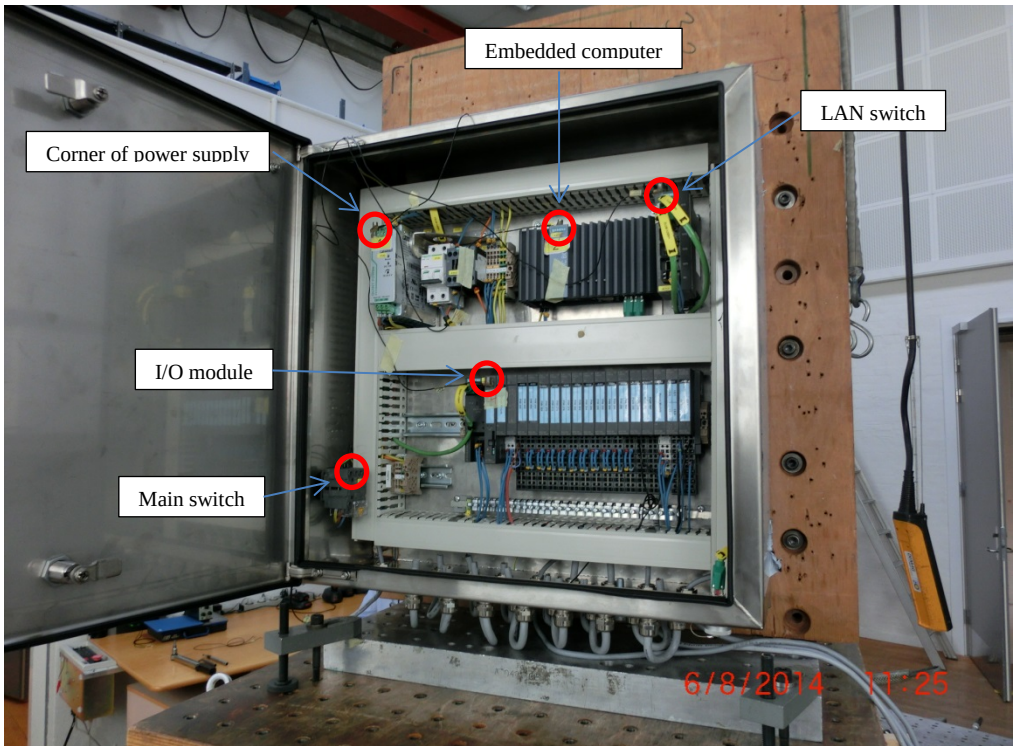


Photo 5 Vibration, resonance search, mounting of accelerometer (measuring points).

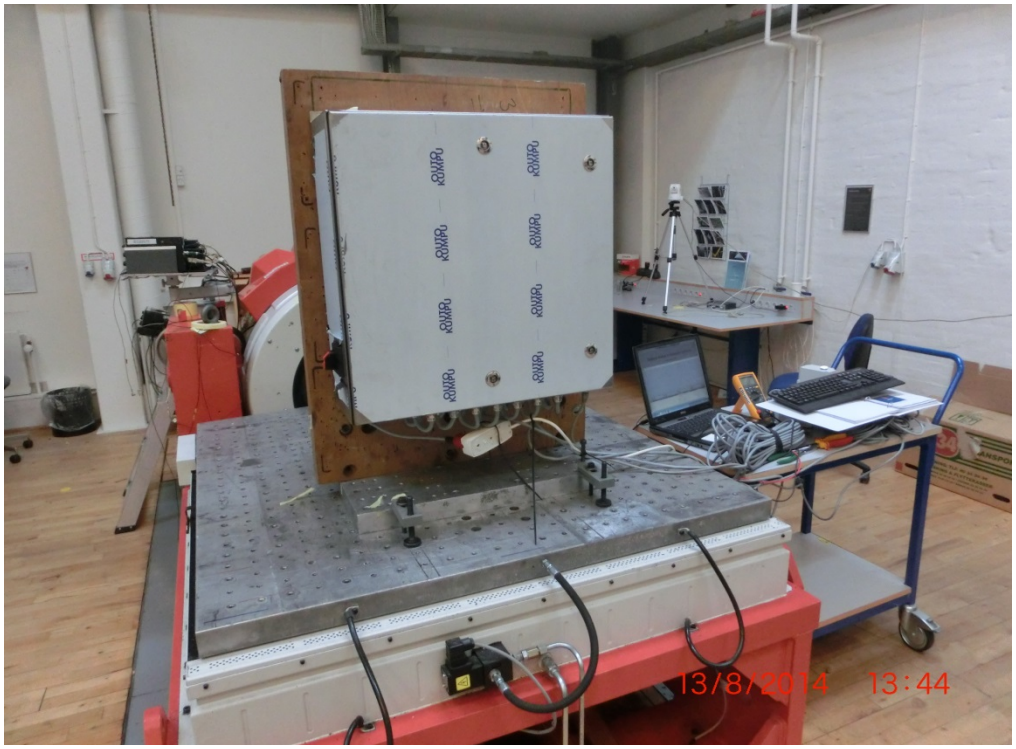


Photo 6 Vibration, endurance, e.g. X-axis.

Photo 7 Electrostatic discharge.

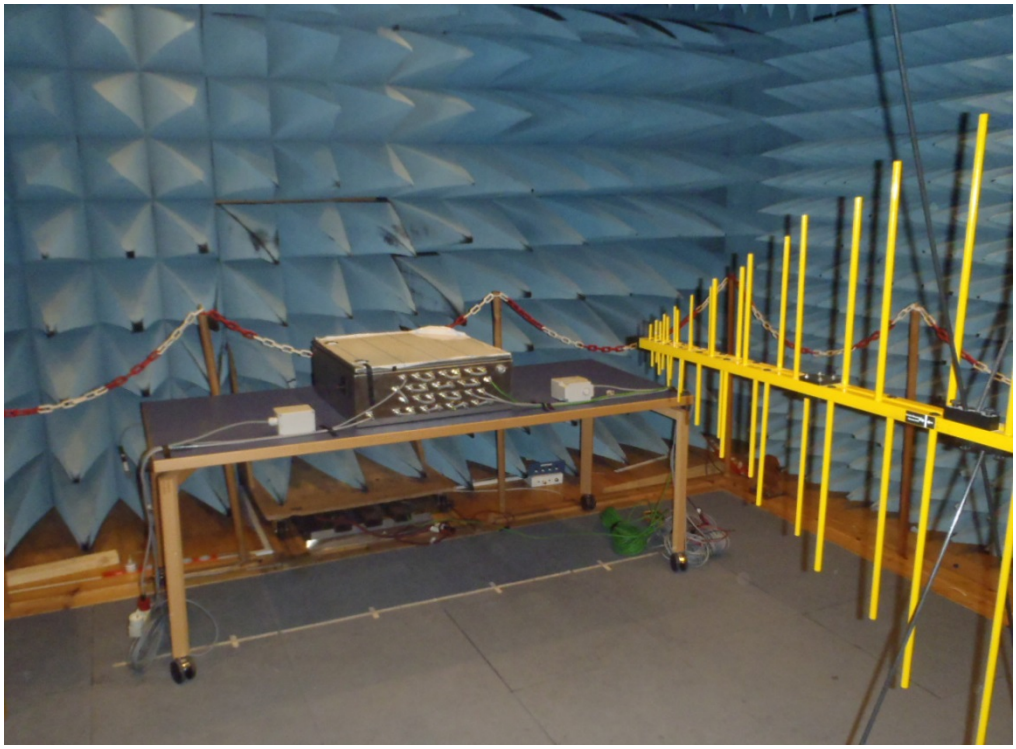


Photo 8 Radiated radio frequency interference (80 - 1000 MHz).

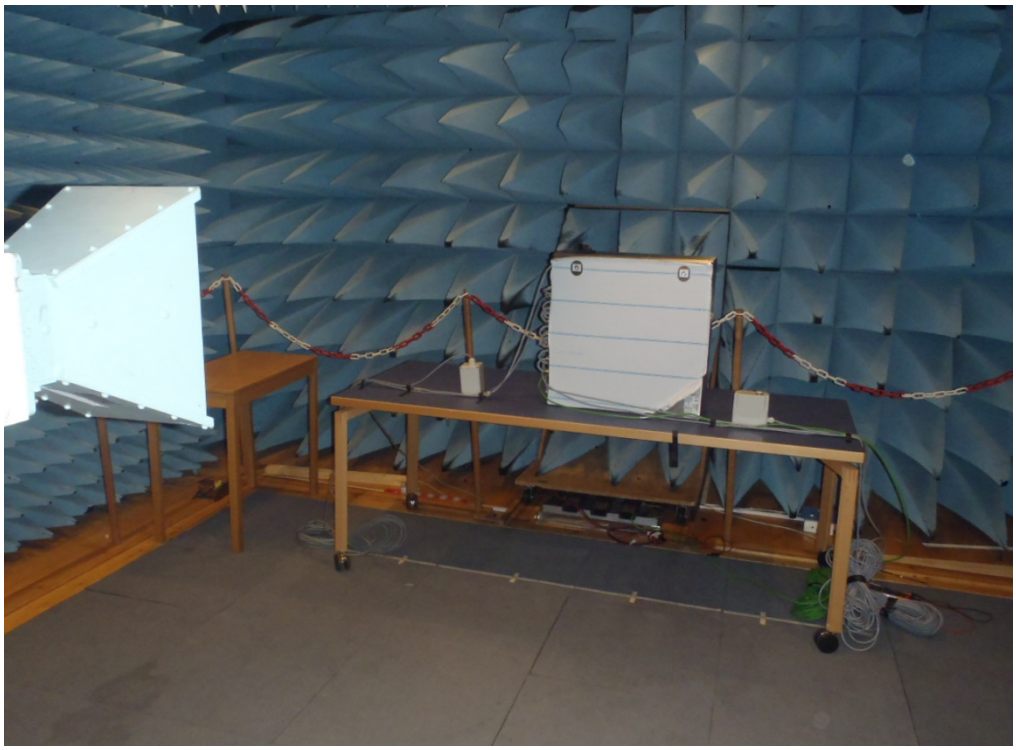


Photo 9 Radiated radio frequency interference (1000 - 2000 MHz).

Photo 10 Conducted low frequency interference.

Photo 11 Conducted radio frequency interference.

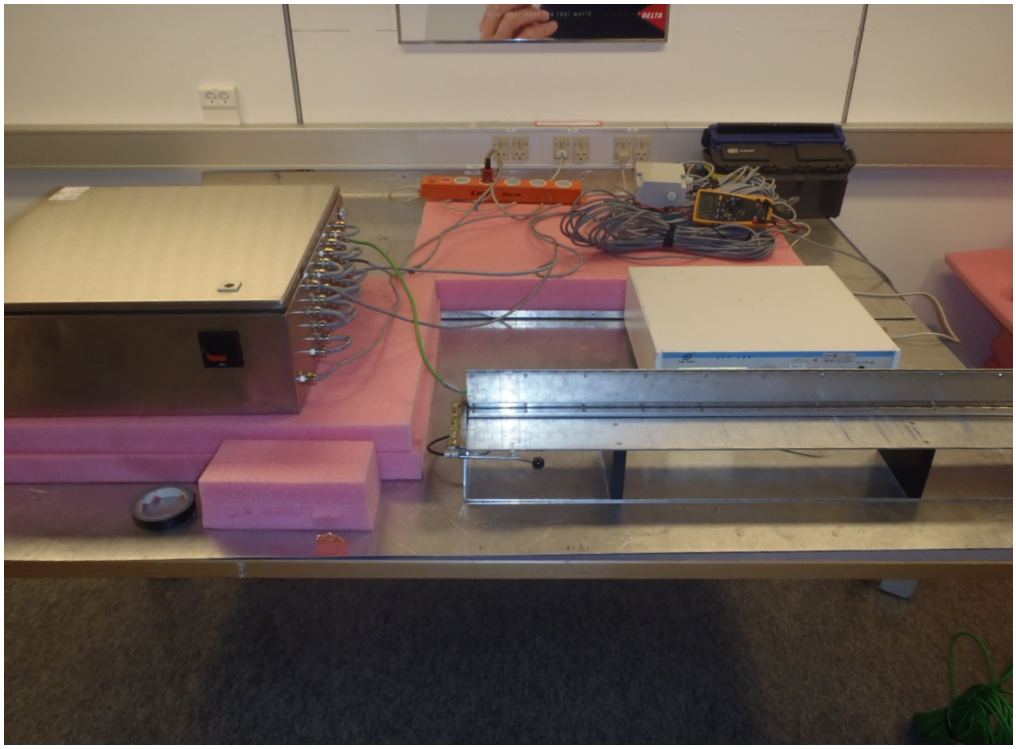


Photo 12 Fast transients - burst.

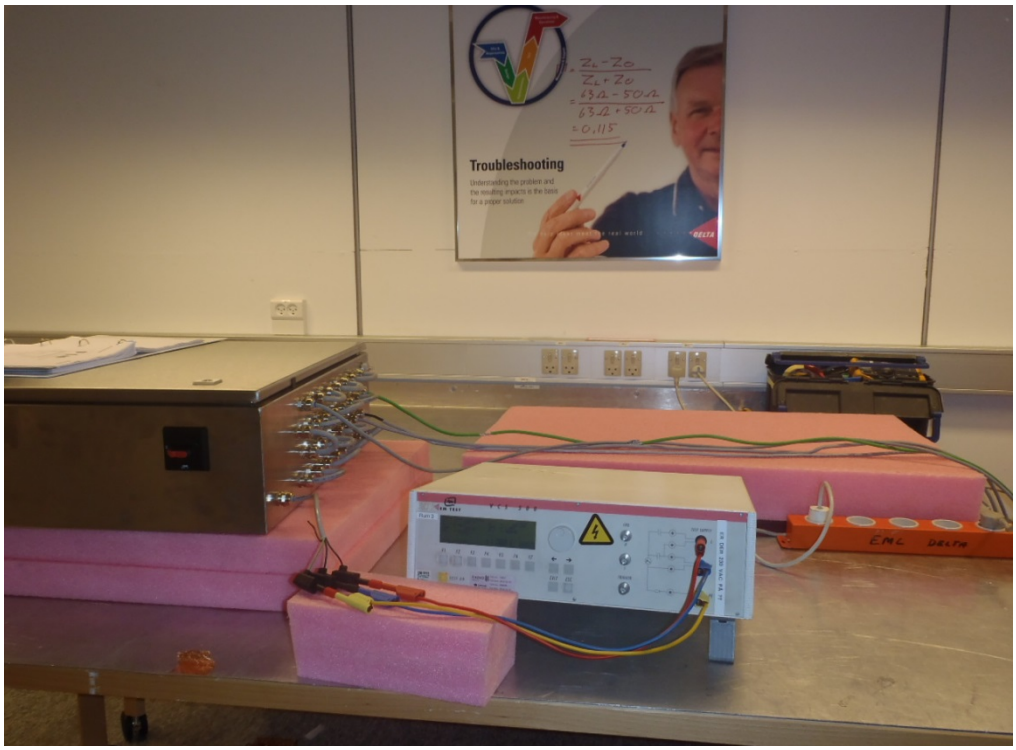


Photo 13 Slow transients - surge.

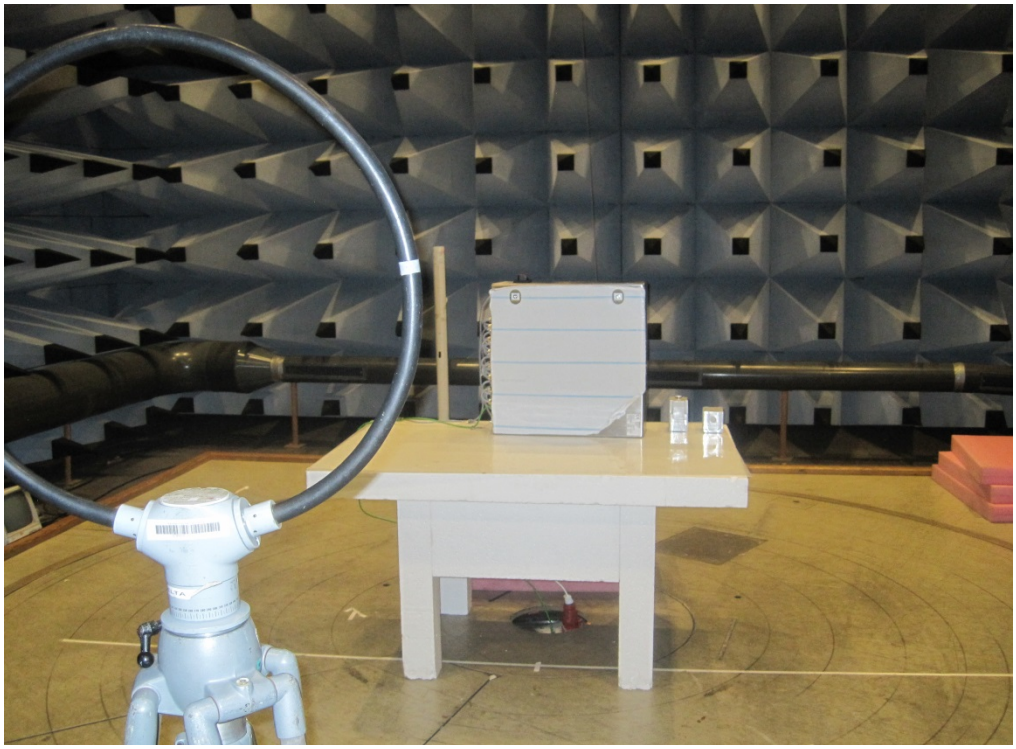


Photo 14 Radiated emission (0.15 - 30 MHz).

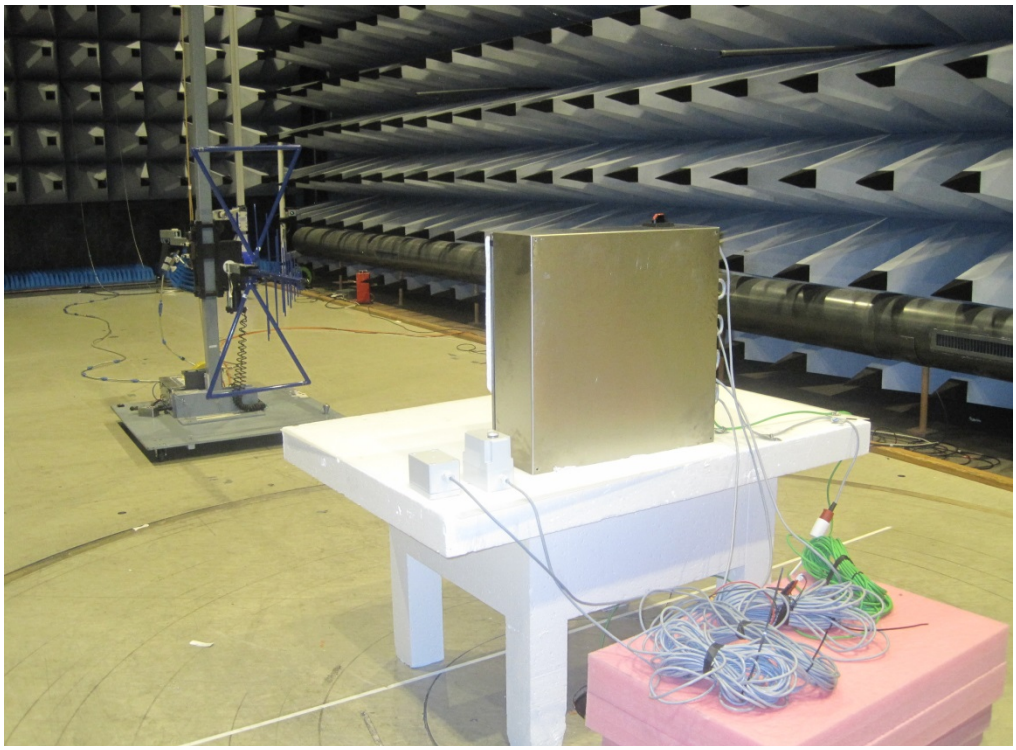


Photo 15 Radiated emission (30 - 2000 MHz).

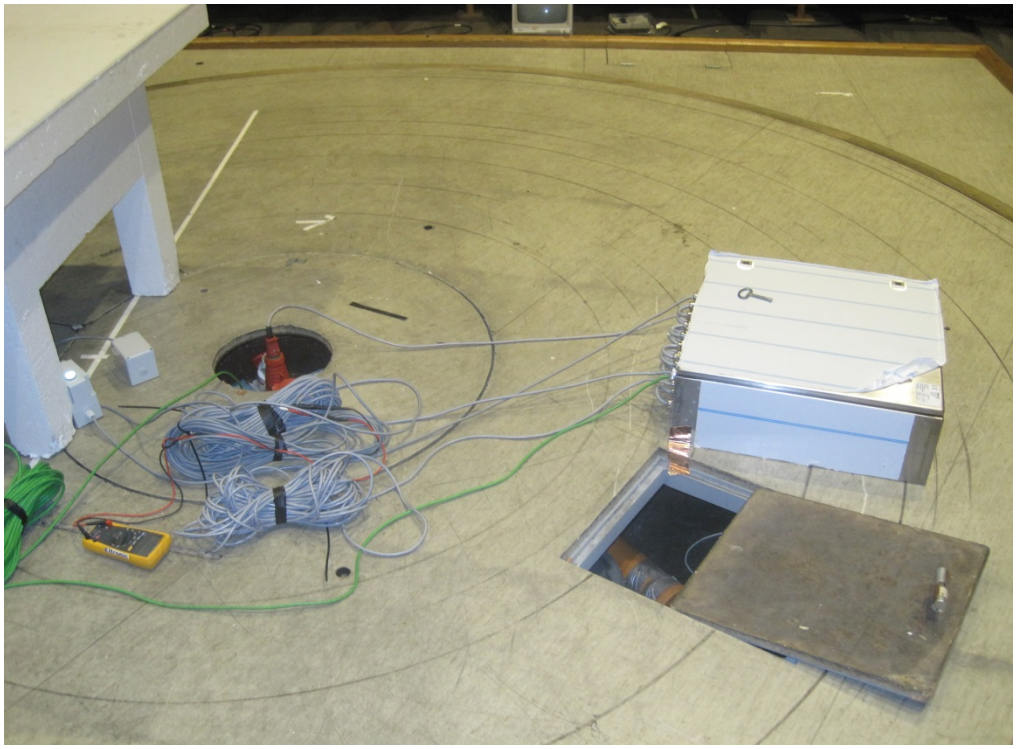


Photo 16 Conducted emission.

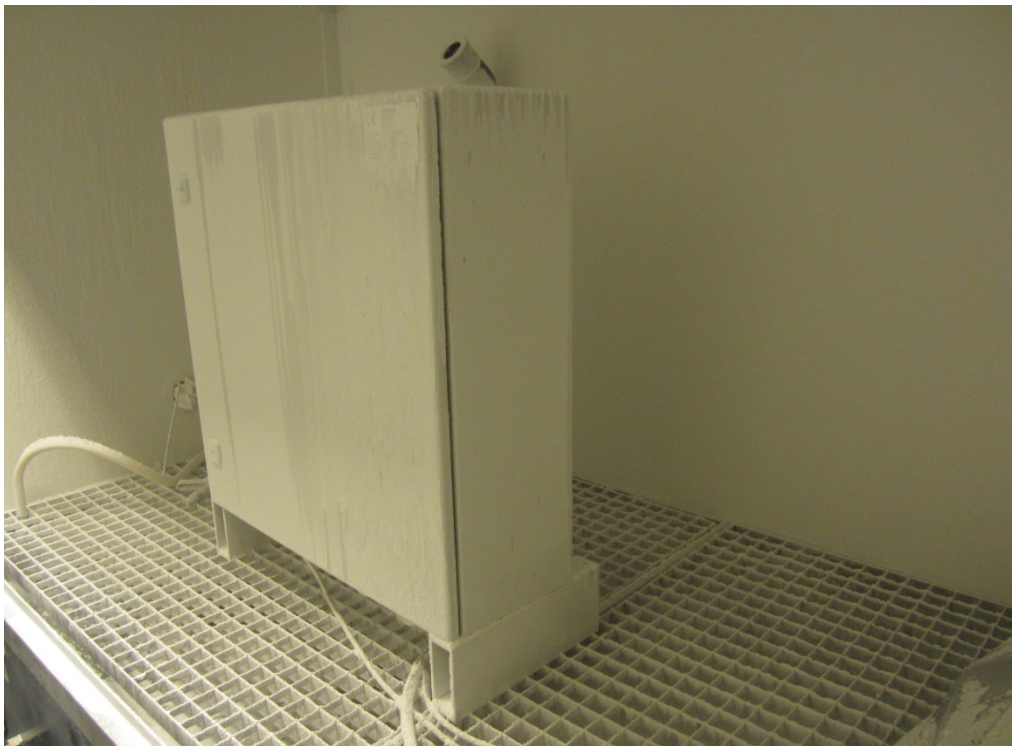


Photo 17 Enclosure protection, IP 5X.

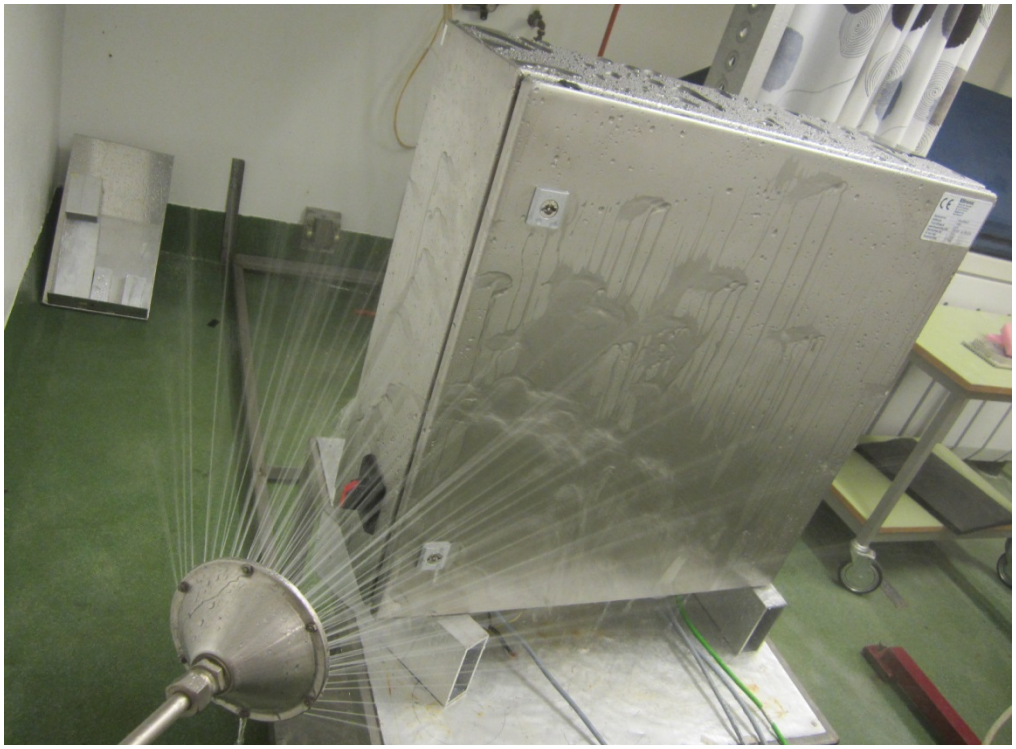
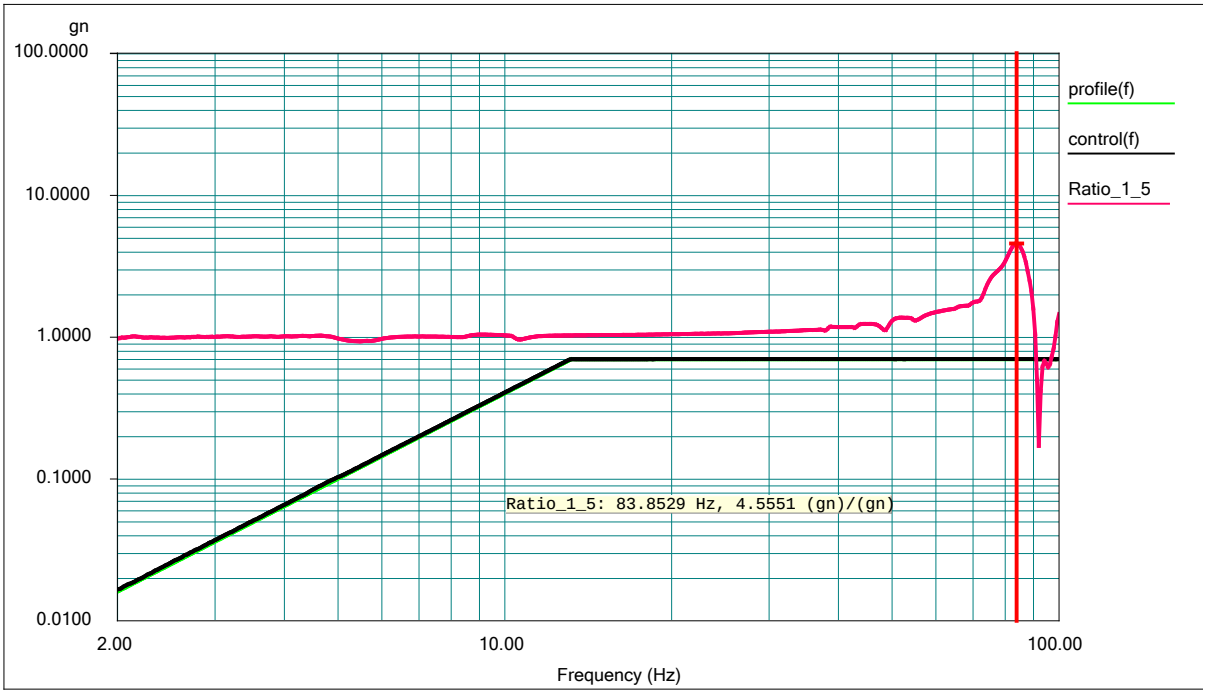


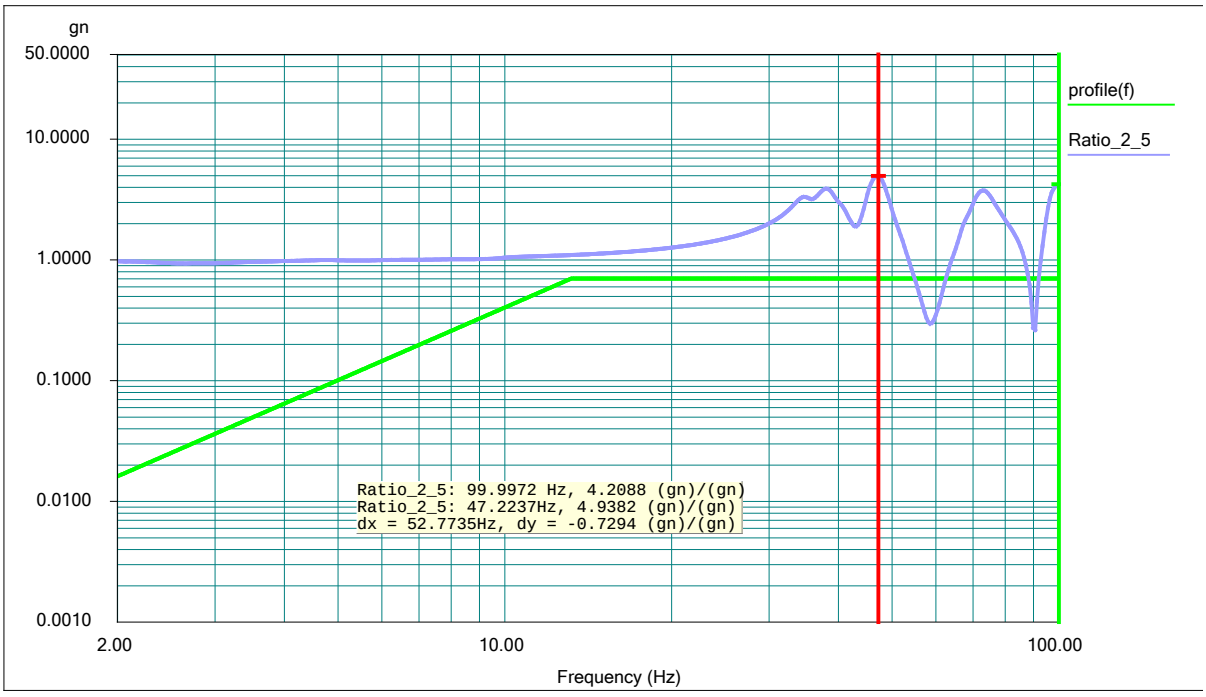
Photo 18 Enclosure protection, IP X4.

Annex 3

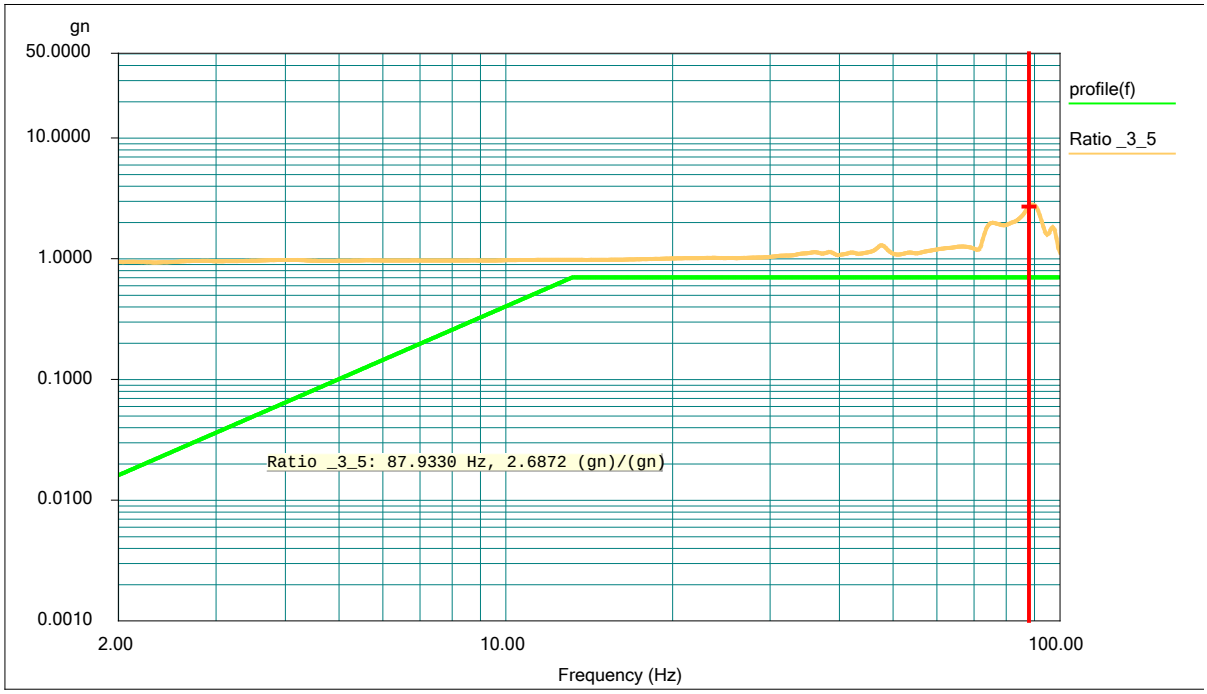
Measurement curves - Vibration



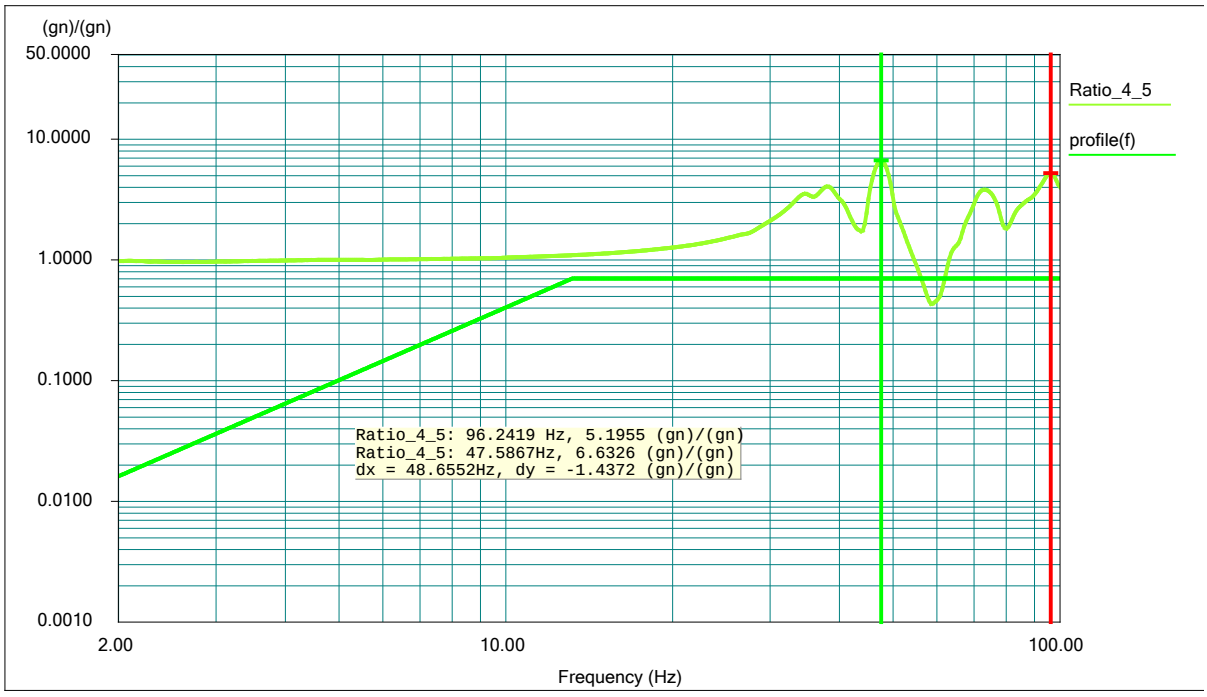
Curve 1 Resonance search, Z-axis (max. ampl. fact.), Corner of power supply.



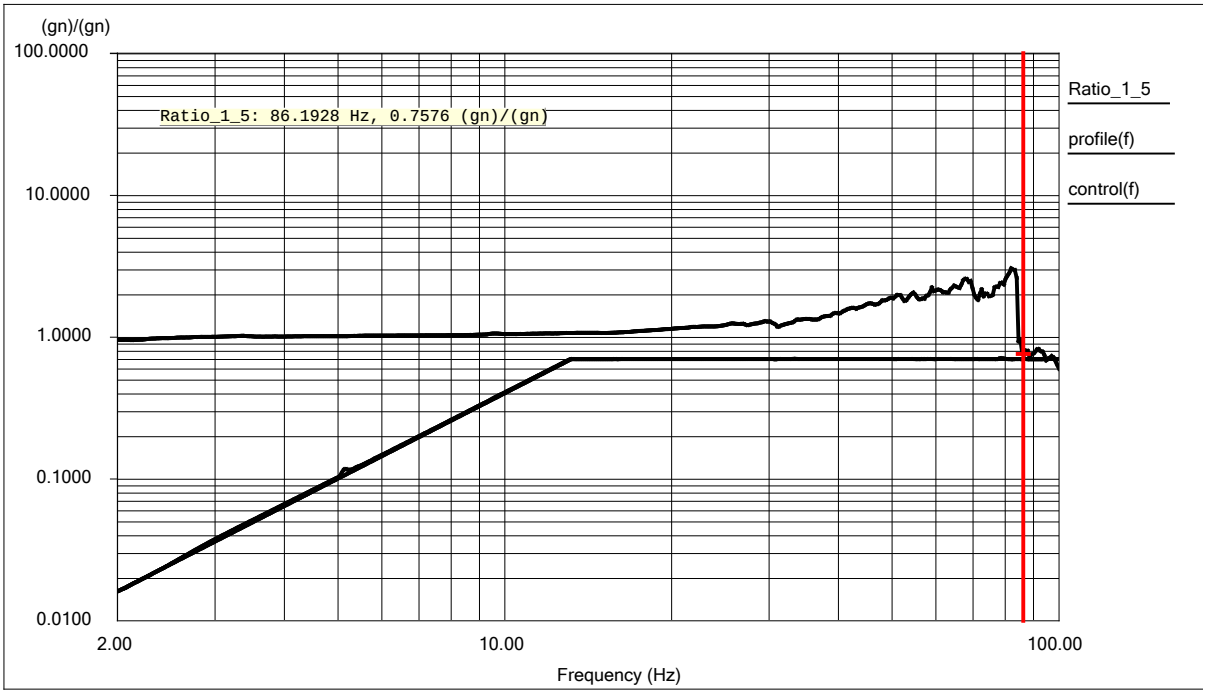
Curve 2 Resonance search, X-axis (max. ampl. fact.), Embedded computer.



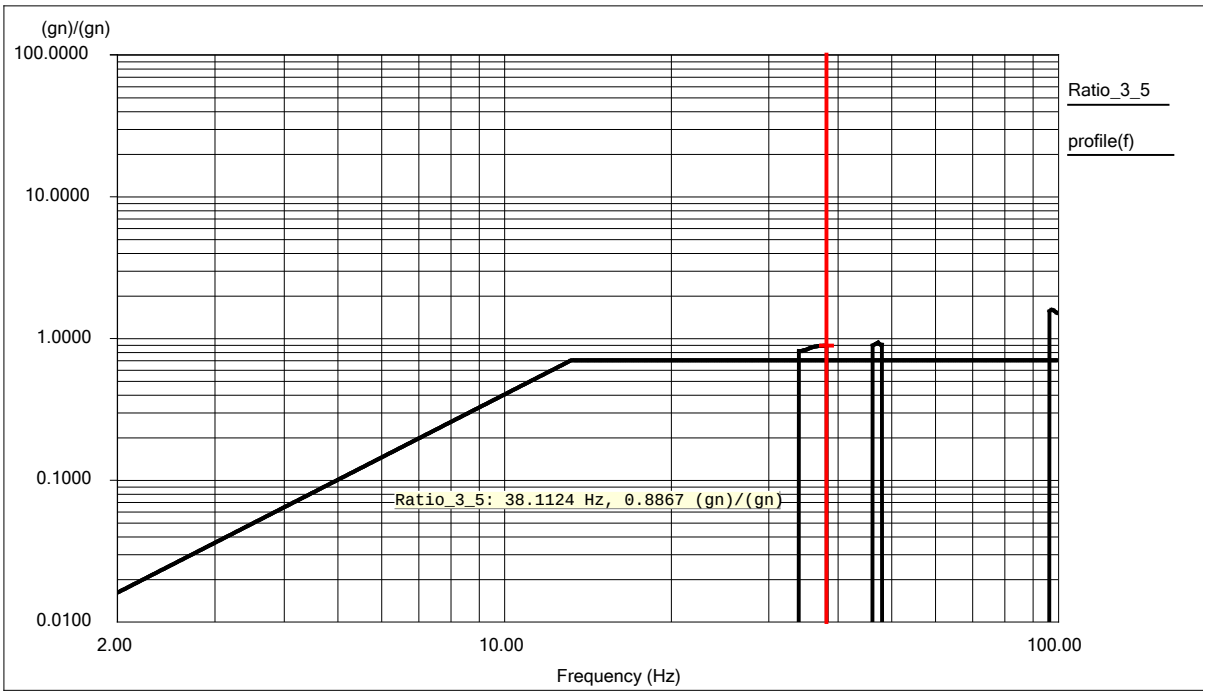
Curve 3 Resonance search, Y-axis (max. ampl. fact.), LAN switch.



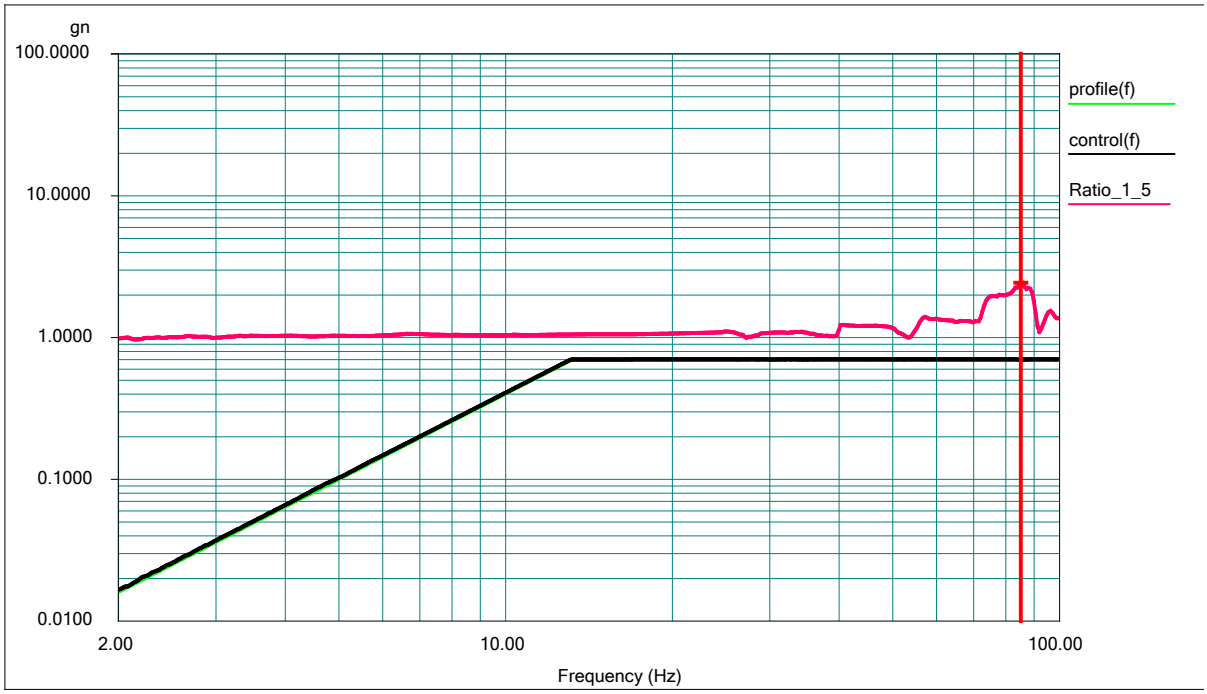
Curve 4 Resonance search, X-axis (max. ampl. fact.), I/O module.



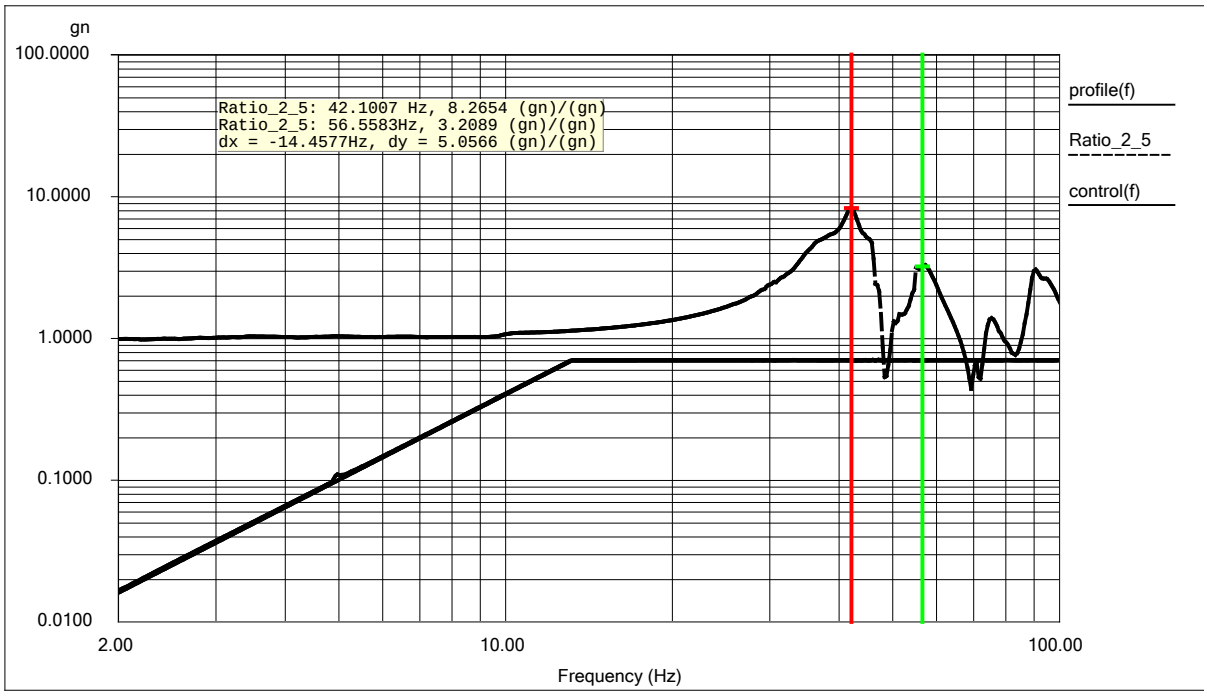
Curve 5 Resonance search, Y-axis (max. ampl. fact.), Main switch.



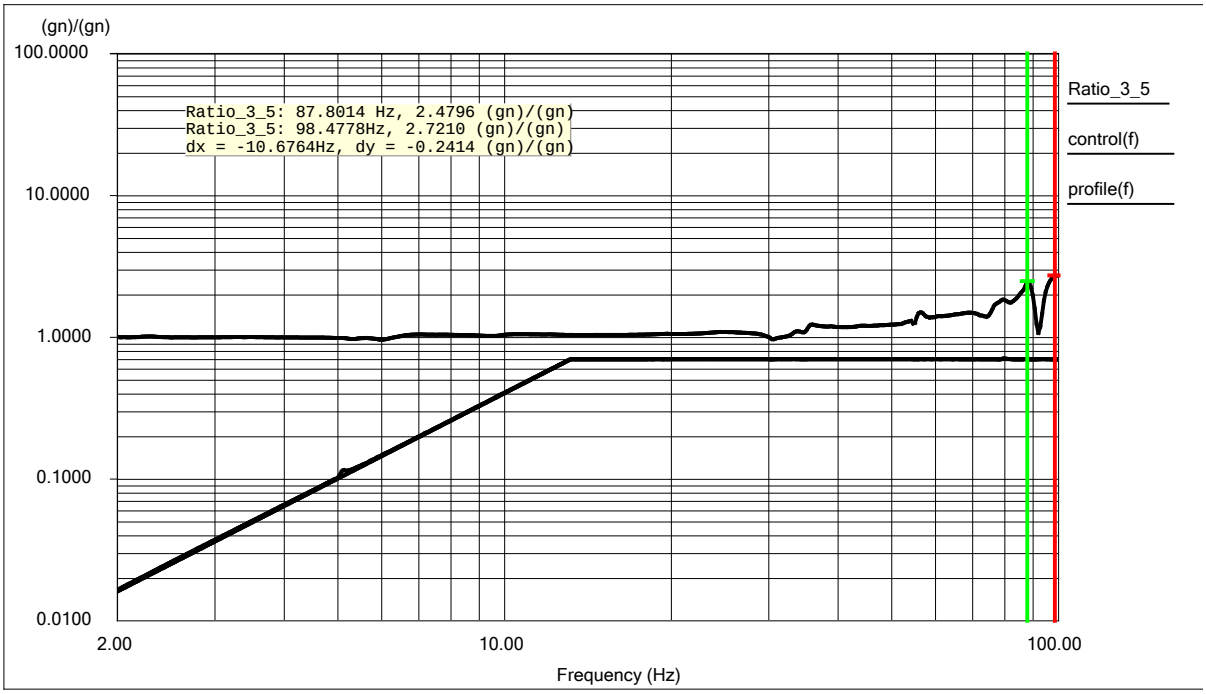
Curve 6 Endurance vibration, e.g. X-axis, 0.7 g.



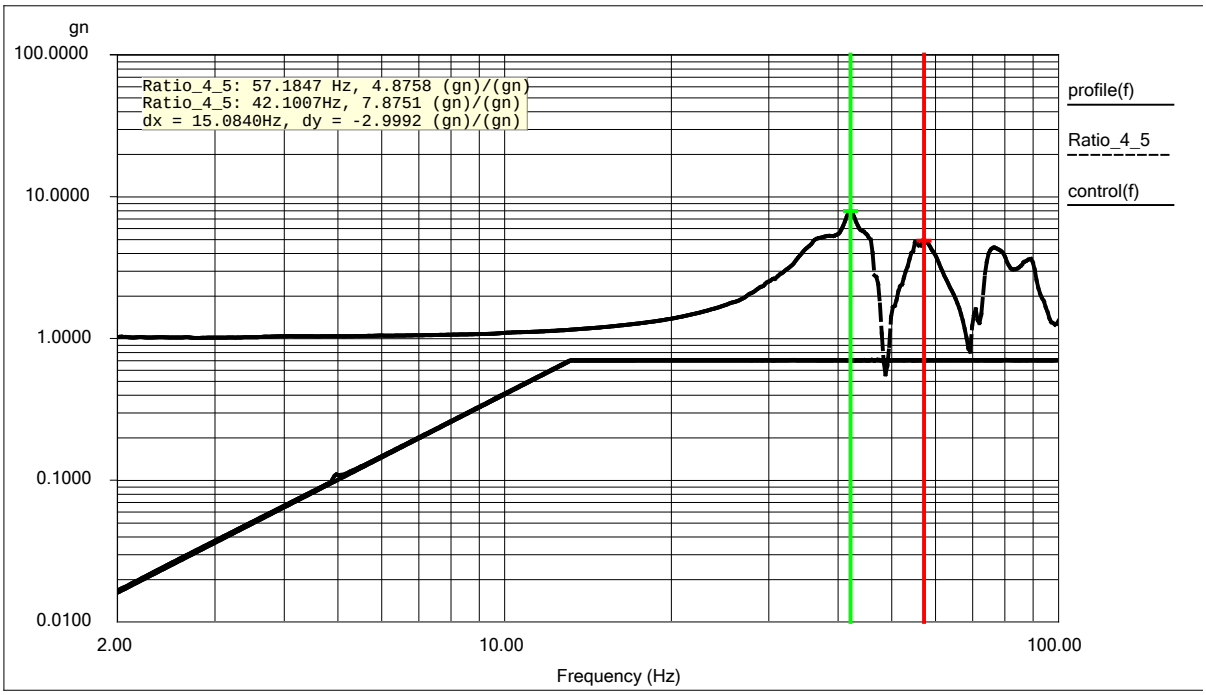
Curve 7 Resonance search, Z-axis after endurance (max. ampl. fact.), Corner of power supply.



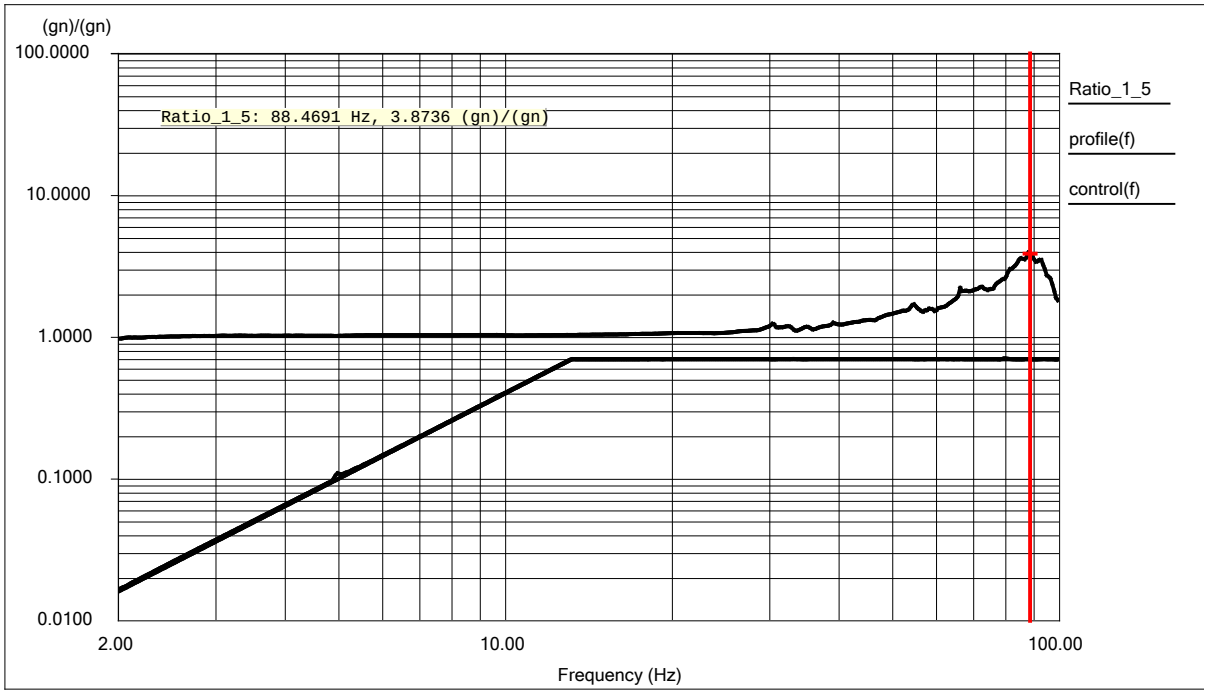
Curve 8 Resonance search, X-axis after endurance (max. ampl. fact.), Embedded computer.



Curve 9 Resonance search, Y-axis after endurance (max. ampl. fact.), LAN switch.

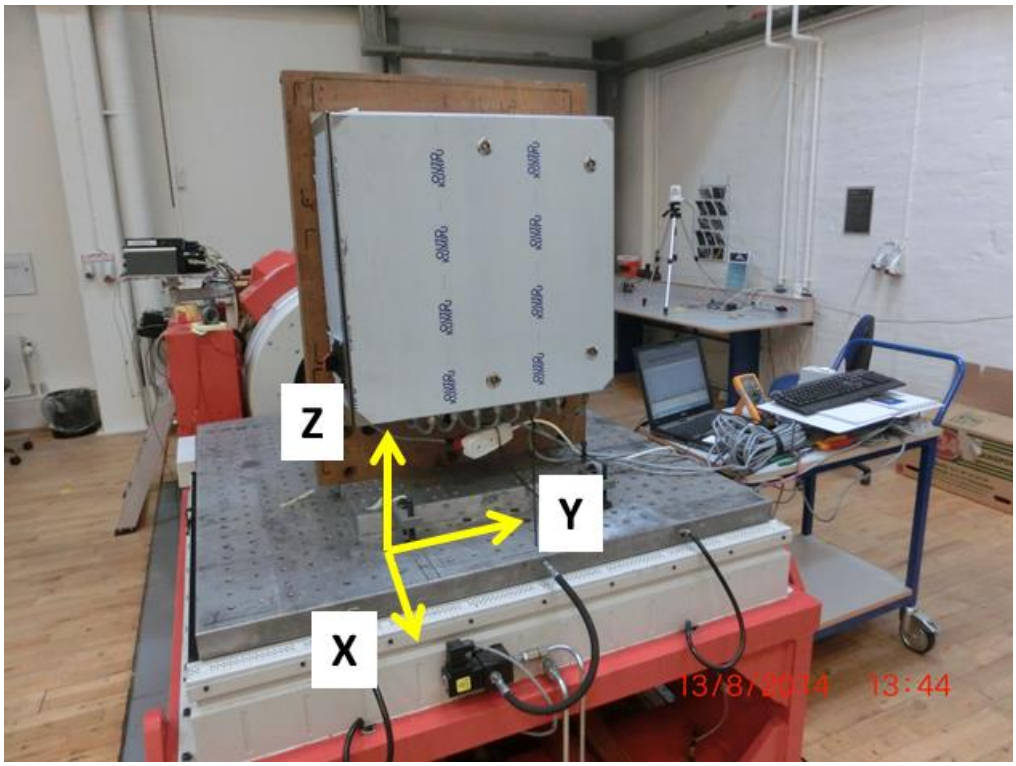


Curve 10 Resonance search, X-axis after endurance (max. ampl. fact.), I/O module.



Curve 11 Resonance search, Y-axis after endurance (max. ampl. fact.), Main switch.

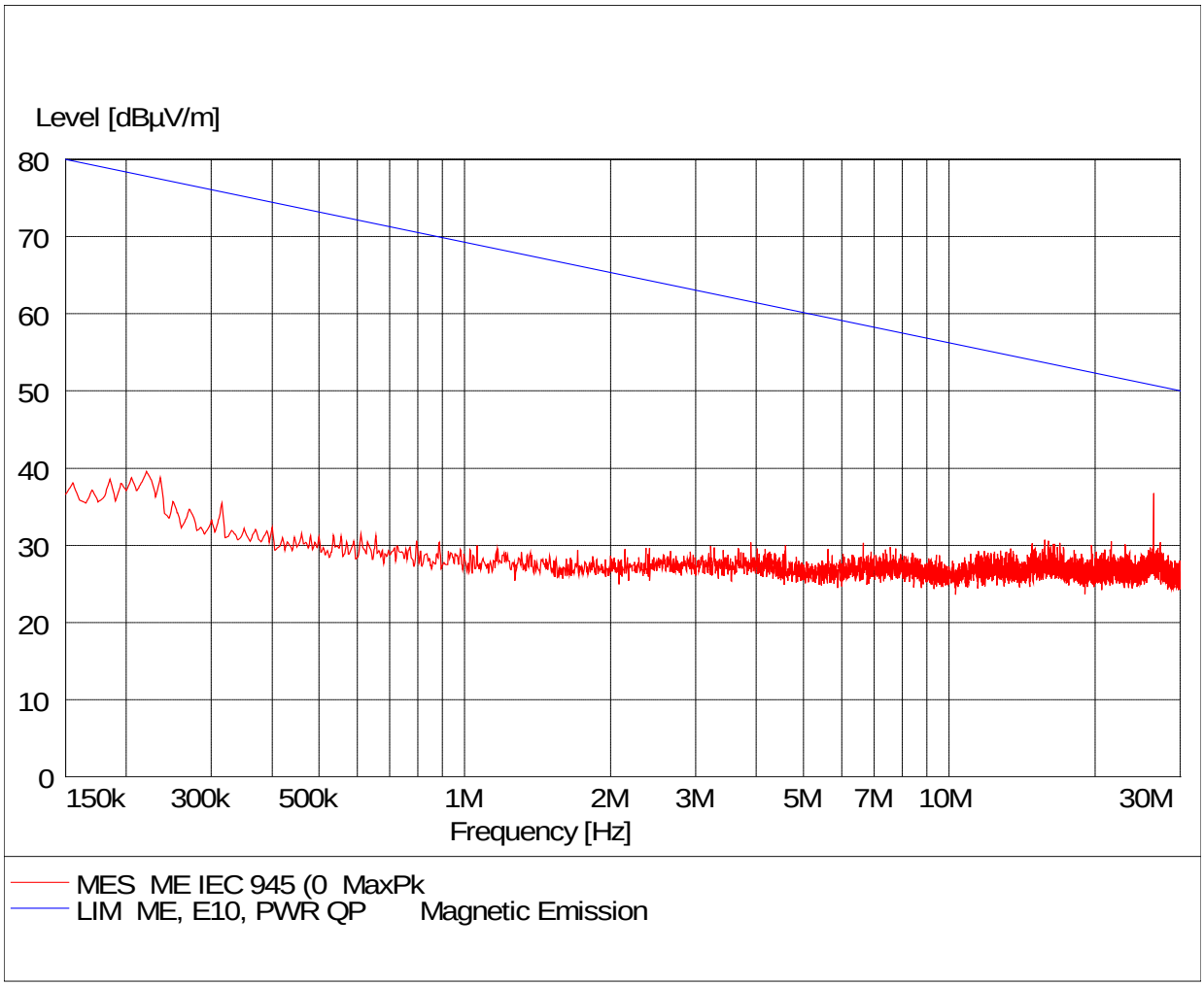
Definition of axes



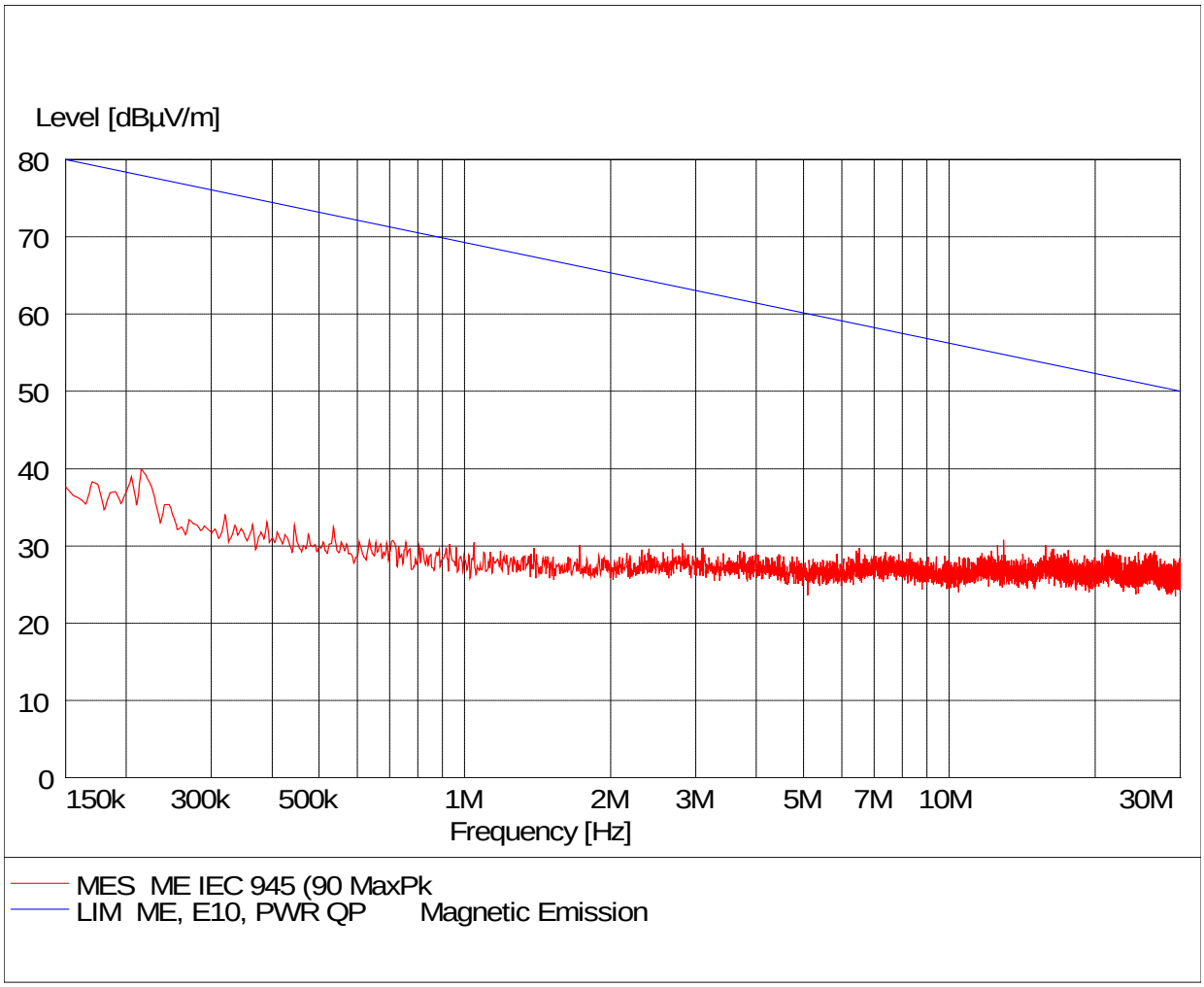
Annex 4

Test record sheets - Radiated emissions

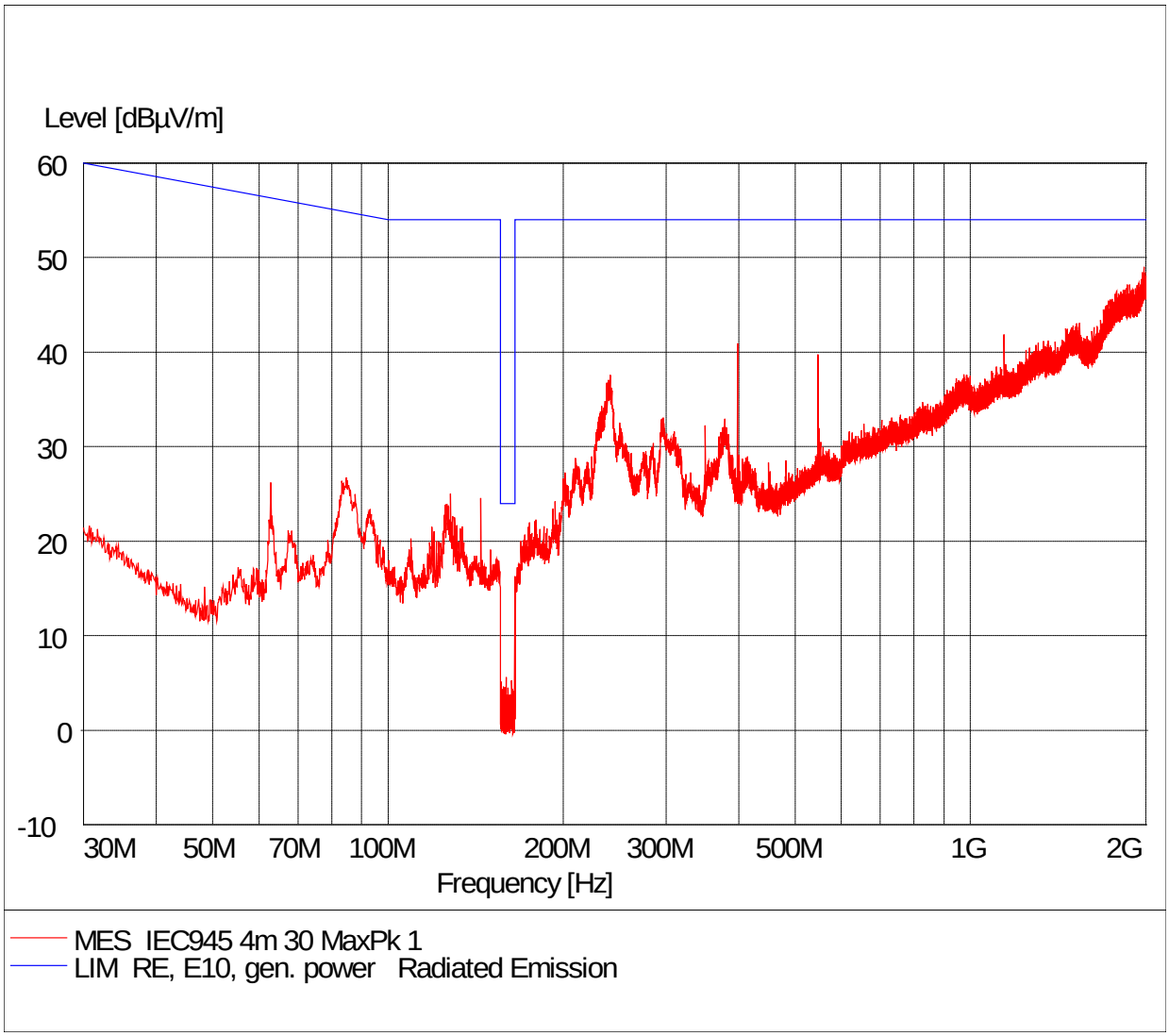
```
Operating Condition: Ant.: 0deg. Voltage 230VAC
Test Site:           EMC - 5
Operator:            CMT - T208005
Test Specification:  E10
Comment:             Sheet 3
Start of Test:       25-04-2014
```



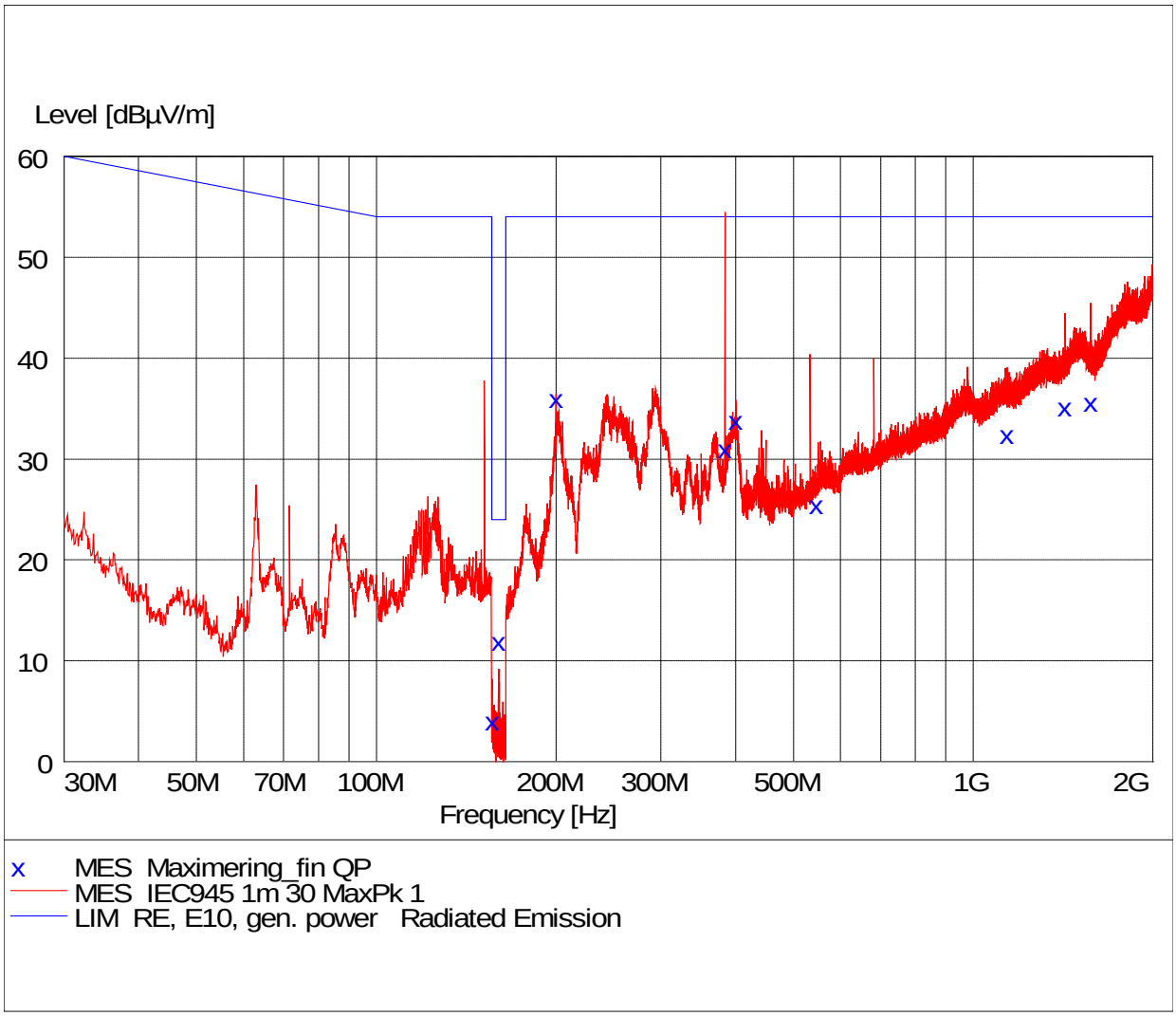
```
Operating Condition: Ant.: 90deg. Voltage 230VAC
Test Site:           EMC - 5
Operator:            CMT - T208005
Test Specification:  E10
Comment:             Sheet 4
Start of Test:       25-04-2014
```



```
Operating Condition: Ant.: 4 meter horizontal. Voltage 230VAC
Test Site:           EMC - 5
Operator:            CMT - T208005
Test Specification:  E10
Comment:             Sheet 6
Start of Test:       25-04-2014
```



Operating Condition: Ant.: 1 meter vertical. Voltage 230VAC
Test Site: EMC - 5
Operator: CMT - T208005
Test Specification: E10
Comment: Sheet 5
Start of Test: 25-04-2014



MEASUREMENT RESULT: "Maximering_fin QP"

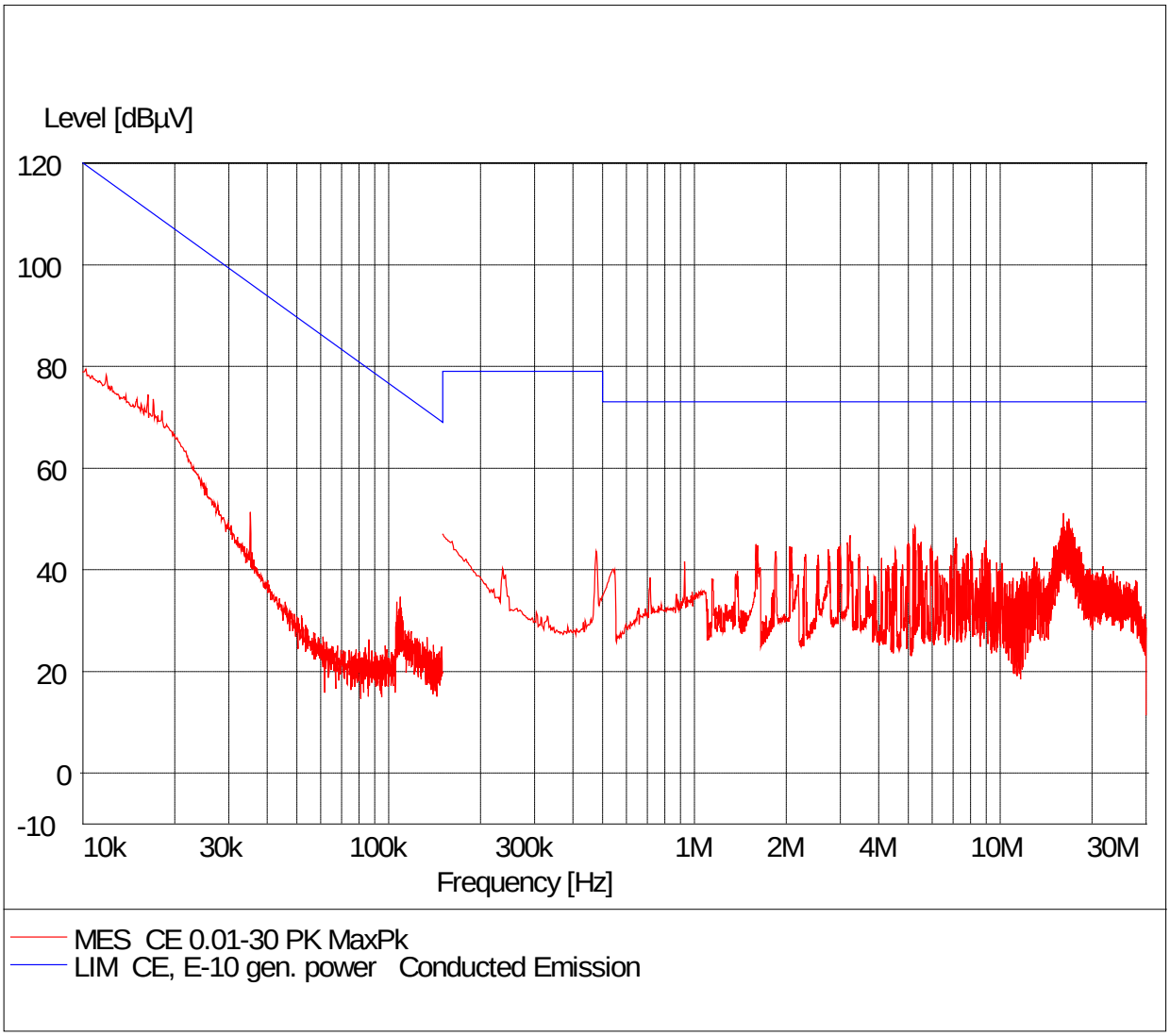
25-04-2014 12:15

Frequency MHz	Level dBµV/m	Transd dB	Limit dBµV/m	Margin dB	Height cm	Azimuth deg	Polarisation
156.460000	4.20	12.5	24.0	19.8	113.0	333.00	HORIZONTAL
160.440000	12.10	12.1	24.0	11.9	162.0	20.00	VERTICAL
200.000000	36.20	12.1	54.0	17.8	158.0	165.00	HORIZONTAL
384.200000	31.20	19.4	54.0	22.8	105.0	321.00	VERTICAL
400.000000	34.00	19.9	54.0	20.0	121.0	185.00	VERTICAL
546.860000	25.60	24.6	54.0	28.4	129.0	123.00	HORIZONTAL
1141.200000	32.60	32.6	54.0	21.4	169.0	0.00	HORIZONTAL
1424.800000	35.30	35.9	54.0	18.7	327.0	256.00	HORIZONTAL
1573.400000	35.80	37.0	54.0	18.2	101.0	259.00	HORIZONTAL

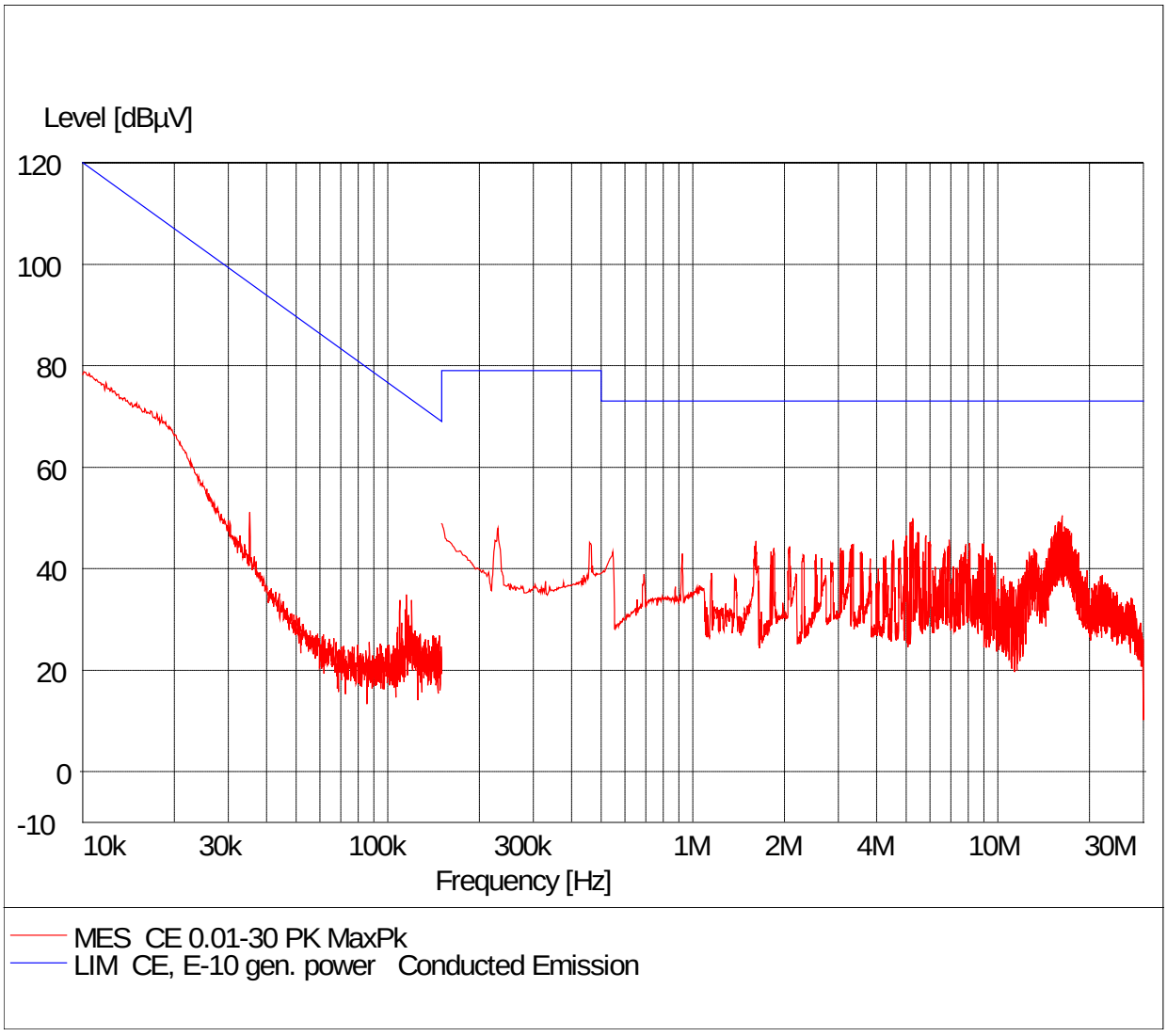
Annex 5

Test record sheets - Conducted emission

```
Operating Condition: Line No.: Neutral. Voltage 230VAC
Test Site:           EMC - 5
Operator:            CMT - T208005
Test Specification:  E10
Comment:             Sheet 1
Start of Test:       25-04-2014
```



```
Operating Condition: Line No.: Line 1. Voltage 230VAC
Test Site:           EMC - 5
Operator:            CMT - T208005
Test Specification:  E10
Comment:             Sheet 2
Start of Test:       25-04-2014
```



Annex 6

Modification of Test Object during Test for Marine Type Approval

(from Client)

Eltronic

1 Description of changes to the mechanical design

During the test process the mechanical layout of the CMU cabinet have been changed. This has happened in multiple steps.

1.1 Components mounting

There are three components in the CMU, which have changed mounting type from "DIN 35 Rail" to directly bolted on to the mounting plate.

- The LAN Switch comes with holes for screw mounting.
- The Nanobox pc were fitted with a custom aluminum mounting plate, and screwed directly on the mounting plate.
- The Powersupply were fitted with a custom aluminum mounting plate and an angular support bracket. Both screwed directly on the mounting plate.

1.2 Changing of cabinet type

The stainless steel electrical cabinet were changed from Rittal to CUBIC. This enabled Eltronic to have a mounting plate custom made.
Beneath is the technical specifications of the two cabinets

	Rittal	CUBIC
Material	Stainless steel (AISI 304)	Stainless steel (AISI 304)
Protection category IP	66	66
K- Factor	5,5	5,5
Door	All-round foamed-in PU sea	Double seal, rubber
Mounting plate	Sheet steel	Custom made sandwich structure
Number of doors:	1	1
Number of cam locks:	2	5

Because the data of the cabinets are equal, the cabinet can be changed from Rittal to CUBIC without any retests besides vibration.

1.2.1 Custom mounting plate

CUBIC have in co-operation with Eltronic developed a customized mounting plate, designed to withstand the chocks and vibrations that the cabinet faced during the test.

2 CMU Cabinet marking

The following marking is found on the first cabinet in the series of CMU cabinets. This cabinet was the one that went through test at Delta.

CE **Eltronic**
Eltronic A/S, Kilde Allé 4
DK-8722 Hedensted
Tel. +45 76 74 01 01
info@eltronic.dk
www.eltronic.dk

Serienummer	124-00526-01
Reference	+AB01
Fremstillingsår	2014
Mærkesp. (U e)	230 VAC - N - PE 50 Hz
Mærkestrøm (I e)	10 A
IK max (I cp)	10 kA
Systemjording	TN-S

REPORT
issued by an Accredited Testing Laboratory

Date	Reference	Page
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1002
ISO/IEC 17025

Handled by, department
Henrik Andersson
Electronics
010-516 55 74, henrik.andersson@sp.se

CUBIC-Modulsystem A/S
Lars Byg
Skjoldborgsgade 21
DK-9700 Brønderslev
Denmark

Classification of degree of protection provided by enclosure
(1 appendix)

1 Client

CUBIC-Modulsystem A/S, Skjoldborgsgade 21, DK-9700 Brønderslev, Denmark.

2 Test item

One cabinet type 8x12y325 rustfri standard skab.
Dimensions approximately 1200 mm x 800 mm x 320 mm (H x W x D).

Photographs according to appendix 1.

The test item arrived at SP on 2011-07-01.

3 Commission

Classification of degree of protection provided by enclosure according to IEC 60529:2001, IP66, with IEC 61439-1:2009 (clauses 8.2.2 and 10.3) as reference.

4 Performance

The tests were performed by Henrik Andersson between 2011-07-01 and 2011-07-05, according to the commission.

The tests were performed with the test item in its normal vertical position of use.

4.1 Test with probe (IP6X)

The test was performed with a ø1 mm test probe pushed against all openings of the test item with a force of 1 N.

4.2 Dust test (IP6X)

The test item was exposed to talcum powder in a dust chamber during 8 h.

The pressure inside the enclosure of the test item was maintained 20 mbar below the surrounding atmospheric pressure by means of a vacuum pump.

The amount of talcum powder was 2 kg per m^3 of the test chamber volume.

4.3 Water jet test (IPX6)

The test item was exposed to water jet from all directions during 3 min and 10 s (1 min/m^2), by means of a ø12.5 mm nozzle.

The water flow was 100 l/min and the distance between the nozzle and the test item was 2.5 m-3.0 m.

The temperature of the water and in the test lab was 20 °C.

5 Result

The tested item fulfilled the requirements for protection against penetrating solid objects, dust and water according to IP66.

The test probe did not penetrate the enclosure.
No dust did penetrate the enclosure.
No water did penetrate the enclosure.

Measuring uncertainties are specified in SP-Method 1486:2009.

The test results apply to the tested item only.

SP Technical Research Institute of Sweden
Electronics - Product Safety

Henrik Andersson
Technical Manager/Officer

Appendix
Appendix 1: Photographs

REPORT

Date	Reference	Page
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Appendix 1

Photographs

SP 302

REPORT

Date	Reference	Page
2011-07-08	FX108102:B	2 (2)

Appendix 1

SP 302

Annex 7

Test setup and functional test procedure

(Provided by the client)

INDUSTRIAL INNOVATION

Eltronic

Ballast water treatment

Client: Bawat A/S

Project No.: 124-00523

Document type: Delta test specification

28-03-2014

Eltronic A/S • Kilde Allé 4 • DK-8722 Hedensted • Tel. +45 76 74 01 01 • CVR-nr.: DK-17 02 42 80 • info@eltronic.dk • www.eltronic.dk

Eltronic

Table of content

Eltronic

1 Introduction

The scope of this document is to describe the test program running on CMU unit system for the Ballast water treatment.

The CMU unit, from company Bawat, is used to control treatment of ballast water.

This CMU unit shall have a shake, rattle and roll tests done at Delta, an institute for e.g. test of HW equipment.

The test shall be done after USCG and DNV standard

Purposes of this test are to show that the equipment can run during the shake, rattle and roll test, so the requirements in USCG, G8 ANNEX 4 RESOLUTION MEPC.174(58) Adopted on 10 October 2008 GUIDELINES FOR APPROVAL OF BALLAST WATER MANAGEMENT SYSTEMS (G8) and DNV STANDARD FOR CERTIFICATION No. 2.4 ENVIRONMENTAL TEST SPECIFICATION FOR INSTRUMENTATION AND AUTOMATION EQUIPMENT APRIL 2006 are full filled.

There will be installed a test program in the CMU unit, where the test program shall run continual under the full test to document a proper function of the CMU unit.

2 Test description for CMU unit.

HW configuration and description of the test conditions during the shake rattle and roll test.

Connections to the CMU unit during Delta test.

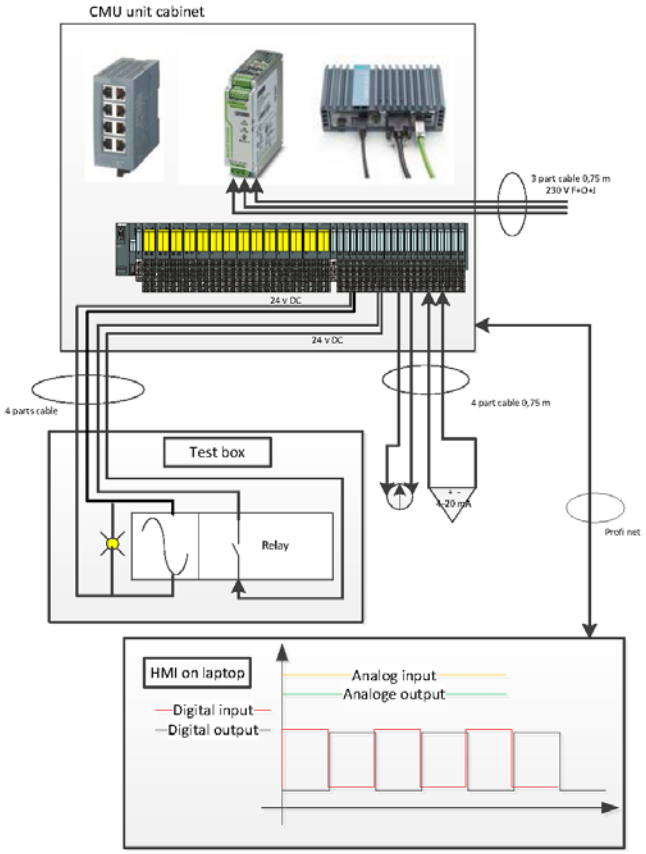
- Supply to CMU unit is 230v AC
- One PROFINET connection to an external laptop, to show the CMU unit test image on the HMI
- One digital input
- One digital output
- One analog input
- One analog output
- Description for CMU unit test program

Test program description for CMU unit during Delta test.

- Test program in the CMU unit, shall run continual under the full test to document a proper function of the CMU unit.
- HMI screen with a trend graph to display digital and analog signals under test run
- Digital Input is a 24v DC input from a relay.
- Digital output is a 24v dc command to relay with an oxalating on/off sequins (on 1 min of 1 min)
- A 4-20 mA generator for a fixed analog input e.g.10 mA
- Display the analog output as a value of the analogue input – 2 mA

Eltronic

2.1 Overview



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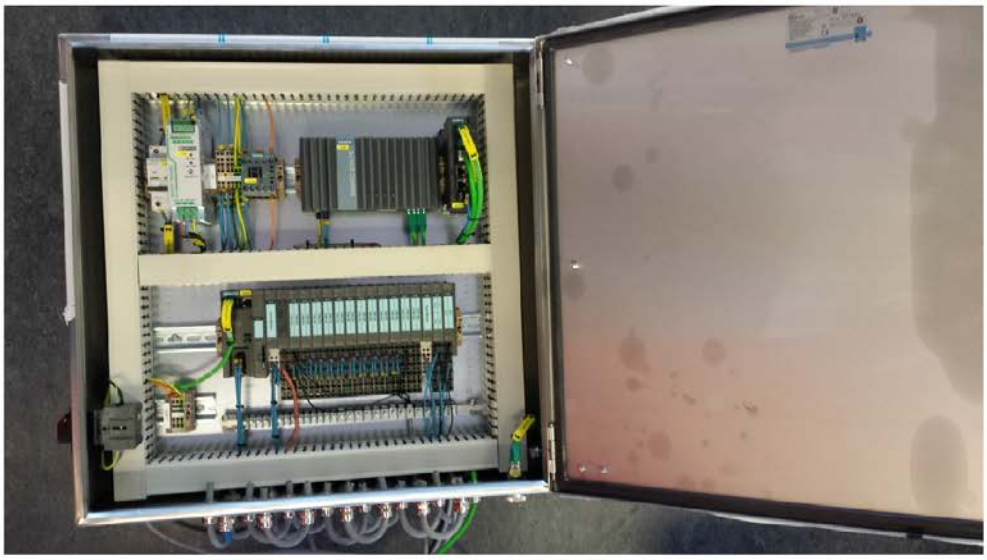
2.2 Picture of CMU unit



2.3 Abbreviations

CMU	Control Monitoring Unit for ballast water treatment

3 Change log

Date	Name	Version	Description
11-03-2014	Frank Nielsen	01	Creation of test document.